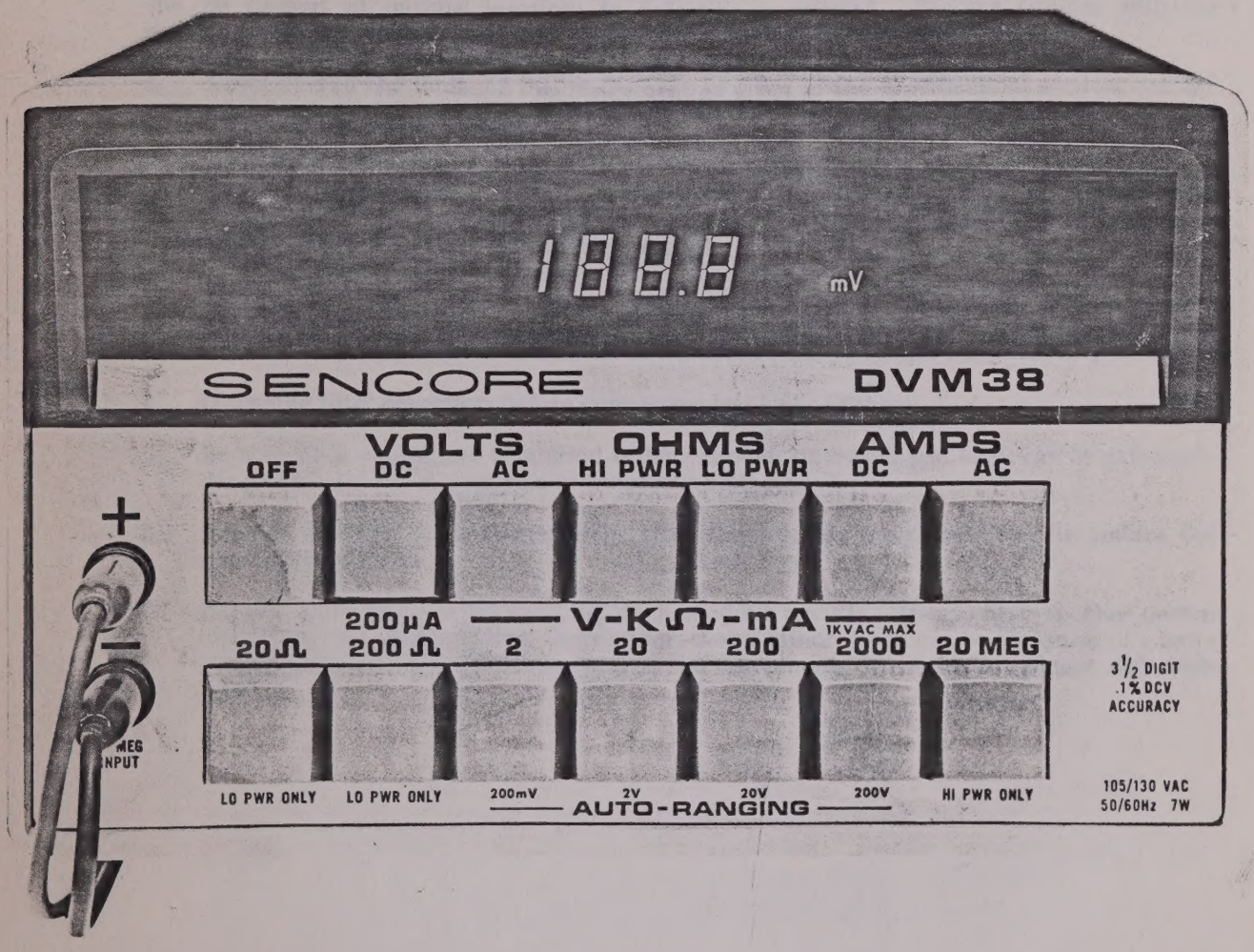
DVM38

DIGITAL MULTIMETER

OPERATION, APPLICATION, & SERVICE MANUAL



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Electronic Services - Los Angeles
M14950X

SE RE

THE ALL AMERICAN LINE OF HIGH QUALI TEST EQUIPMENT

SENCORE SAFETY REMINDER

Every precaution has been taken in the design of your instrument to insure that it is as safe as possible. However, safe operation depends on you, the operator.

There is always a danger present when testing electronic equipment. Unexpected high voltages can be present at unusual locations in defective equipment. Become familiar with the equipment you're working with, and observe the following safety precautions.

1. Never exceed the limits of this instrument as given in the specifications section, and the additional special warnings in this manual.

2. A severe shock hazard can result if the chassis of the equipment being serviced is tied to the "hot" side of the AC Line. An isolation transformer should always be used with this equipment. Also, be sure that the top of your workbench and the floor underneath it are dry and made of non-conductive material.

3. Remove the circuit power before making connections to high voltage points. If this cannot be done, be sure to avoid contact with other equipment or metal objects. Place one hand in your pocket and stand on an insulated floor to reduce the possibility of shock.

4. Discharge filter capacitors before connecting test leads to them.

5. Be sure your equipment is in good order. Broken or frayed test leads can be extremely dangerous and can expose you to dangerous voltages.

6. Remove the test leads immediately after the test has been completed to reduce the possibility of shock.

7. Do not work alone when working on hazardous circuits. Always have another person close by in case of an accident. Remember, even a minor shock can be the cause of a more serious accident, such as falling against the equipment, or coming in contact with high voltages.

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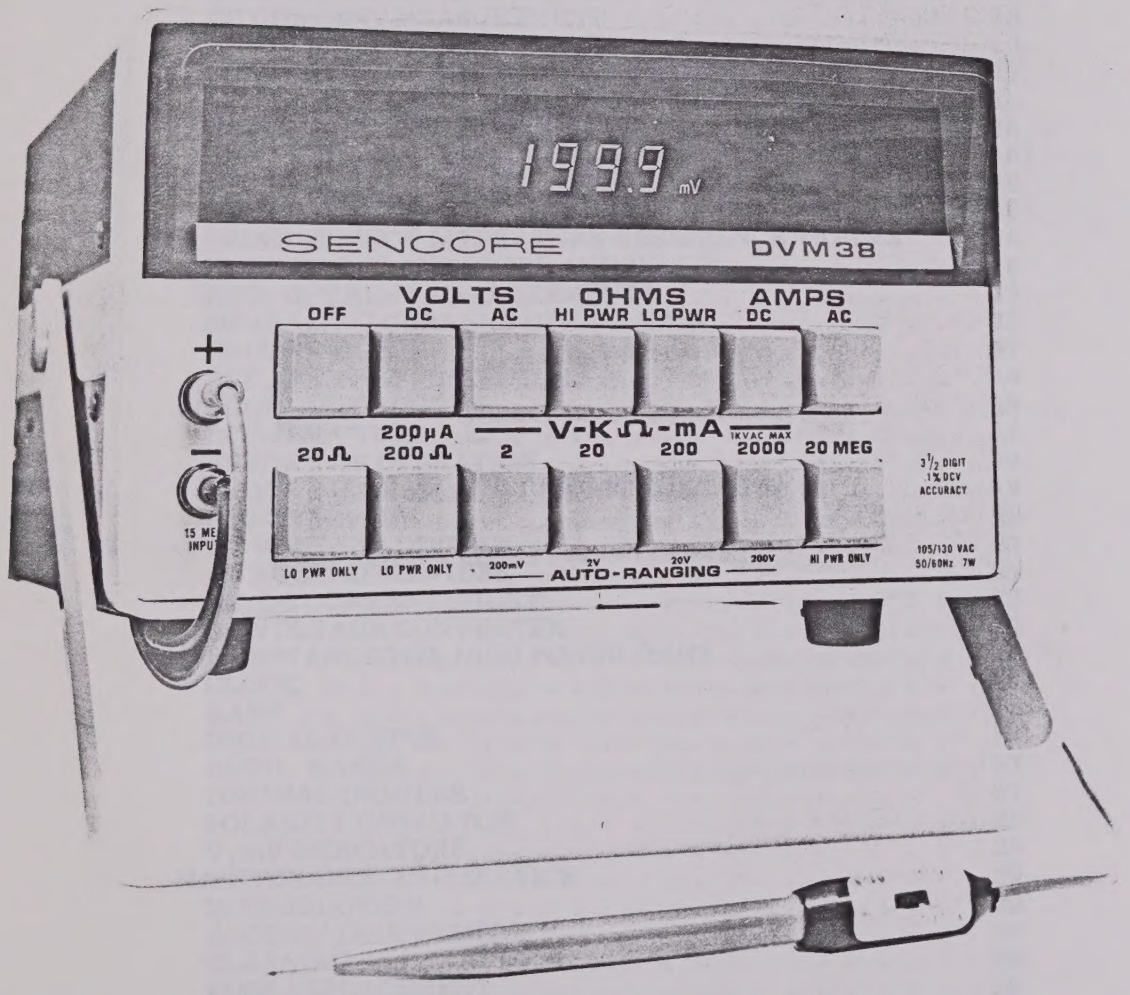

SENCORE

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INTRODUCTION

Until the last few years, very high accuracy digital multimeters were used primarily in the domains of the research, computer, and aerospace fields. DVMs were required because of their high resolution capabilities.

As digital logic technology using TTL and CMOS ICs was improved, DVM application became more widespread. The lower voltage levels and closer tolerances required by the new equipment demanded that high accuracy meters be used. Fortunately, this same technology reduced the DVMs cost to an affordable price. There are now hundreds of digital multimeters available for widespread application.

However, very few of these DVMs seem to have been designed from the viewpoint of the operator using his instrument. The versatility to measure in all circuits — low voltage to very high voltage — while maintaining high resolution and accuracy was rated of primary importance. Speed and ease of operation were also important to engineers having to hunt and peck through rows of switches and confusing readouts.

The DVM38 was designed to meet these requirements. With single-step Auto Ranging, the DVM38 has resolution down to 100uV and range up to 50Kv DC with the HP200 High Voltage Probe (optional accessory). It is more accurate in more circuits since the constant 15 megohm DC input impedance assures up to 50% greater accuracy with less circuit loading. Low level resistance measurements can be made with the 20 ohm range, while the HI - LO POWER ohms functions extend measuring capabilities in solid state circuits.

"Easy - to - operate" best describes the DVM38 human engineered front panel. The 3½ digit display is bright and readable, yet won't cause eye fatigue. The big pushbuttons prevent selection errors, while the two terminal input eliminates switching test leads. Finally, the built-in 2 KVDC overload protection prevents costly meter downtime and time consuming fuse replacement.

High accuracy, more versatility, with speed and ease of operation make the DVM38 the complete DVM for faster, more reliable measurements. It is a new standard in DVMs, backed by the exclusive Sencore 100% Made Right Lifetime Guarantee against factory workmanship errors.

SPECIFICATIONS

DC Voltage : 5 RANGES: 0 to ± 200mV (lower scale only), 2, 20, 200, 2000 volts. Each range automatically increases sensitivity ten times for lower scale when reading is less than 1/10 of full scale.

ACCURACY: Accuracy expressed as percentage of reading ± resolution for the given range.

RANGE	% READING	FULL SCALE	LOWER SCALE
200mV	± .1%	———	± 3 digits
2V	± .1%	± 1 digit	± 3 digits
20V	± .1%	± 1 digit	± 3 digits
200V	± .1%	± 1 digit	± 3 digits
2000V	± .1%	± 1 digit	± 3 digits

INPUT IMPEDANCE: 15 megohms shunted with less than 10pf (in series with 200K ohm when probe isolation is used).

POLARITY: Automatic

RESPONSE TIME: 1 sec. (Max.)

MAX INPUT PROTECTION: 2000V (DC + peak)

AC REJECTION (Normal Mode Rejection): —60db at 50-60Hz on 2, 20, 200 ranges. — 45db at 50-60Hz on 2000 range.

AC Voltage: 5 RANGES: 0 to 200mV (lower scale only), 2, 20, 200, 1000 volts. Each range automatically increases sensitivity ten times for lower scale when reading is less than 1/10 of full scale.

ACCURACY: Accuracy expressed as percentage of reading ± resolution for the given range.

RANGE	% READING	FULL SCALE	LOWER SCALE
200mV	± .5%	———	± 3 digits
2V	± .5%	± 2 digits	± 3 digits
20V	± .5%	± 2 digits	± 3 digits
200V	± .5%	± 2 digits	± 3 digits
1000V	± .5%	± 2 digits	± 3 digits

INPUT IMPEDANCE: 1.5 megohms shunted by less than 40pf.

AC CONVERTER: RMS reading, Average detecting.

RESPONSE TIME: 2 sec. (Max.)

MAX INPUT PROTECTION: 1000VAC (Peak + DC)

FREQUENCY RESPONSE: 40Hz to 5KHz, —.5db

DC Current: 5 RANGES: 0 to ± 200uA, 2, 20, 200, 2000mA.

ACCURACY: Accuracy expressed as percentage of reading ± resolution for the given range.

RANGE	% READING	RESOLUTION	SHUNT RESISTANCE
200uA	± .3%	± 2 digits	1000 ohm
2mA	± .3%	± 2 digits	100 ohm
20mA	± .3%	± 2 digits	10 ohm
200mA	± .3%	± 2 digits	1 ohm
2000mA	± .3%	± 2 digits	.1 ohm

VOLTAGE BURDEN: 200mV on 200uA, 2, 20mA ranges. 300mV or less on 200mA ranges. 1V or less on 2000mA range.

POLARITY: Automatic

RESPONSE TIME: 1 sec. (Max.)

MAX INPUT PROTECTION: 2A (fuse protected)

AC Current: 5 RANGES: 0 to 200uA, 2, 20, 200, 2000mA.

ACCURACY: Accuracy expressed as percentage of reading ± resolution for the given range.

RANGE	% READING	RESOLUTION	SHUNT RESISTANCE
200uA	± 1 %	± 2 digits	1000 ohm
2mA	± 1%	± 2 digits	100 ohm
20mA	± 1%	± 2 digits	10 ohm
200mA	± 1%	± 2 digits	1 ohm
2000mA	± 1%	± 2 digits	.1 ohm

VOLTAGE BURDEN: 200mV on 200uA, 2, 20mA ranges. 300mV or less on 200mA ranges. 1V or less on 2000mA range.

AC CONVERTER: RMS reading, average detecting

RESPONSE TIME: 2 sec. (Max.)

MAX INPUT PROTECTION: 2A (fuse protected).

Resistance (Low Power): 6 RANGES: 0 to 20, 200, 2K, 20K, 200K, 2000K ohm.

ACCURACY: Accuracy expressed as percentage of reading ± for the given range.

RANGE	% READING	RESOLUTION	MAX. CURRENT THRU UNKNOWN R
20 ohm	± .2%	± 3 digits (plus lead resistance)	10mA
200 ohm	± .2%	± 3 digits (plus lead resistance)	1mA
2K ohm	± .2%	± 3 digits	100uA
20K ohm	± .2%	± 3 digits	10uA
200K ohm	± .2%	± 3 digits	1uA
2000K ohm	± .2%	± 3 digits	100nA

MAX VOLTAGE AT LEADS: 200mV at full scale

RESPONSE TIME: 1 sec. (Max.) 20 - 200K ranges. 2 sec. (Max.) 2000K range.

MAX INPUT PROTECTION: 1000V (DC + peak)

Resistance (High Power): 5 RANGES: 0 to 2K, 20K, 200K, 2000K ohm, 20 megohm.

ACCURACY: Accuracy expressed as percentage of reading ± resolution for the given range.

RANGE	% READING	RESOLUTION	MAX. CURRENT THRU UNKNOWN R
2K ohm	± .2%	± 2 digits	1mA
20K ohm	± .2%	± 2 digits	100uA
200K ohm	± .2%	± 2 digits	10uA
2000K ohm	± .2%	± 2 digits	1uA
20M ohm	± .2%	± 2 digits	100nA

MAX VOLTAGE AT LEADS: 2V at full scale

RESPONSE TIME: 1 sec. (Max.) 2K - 2000K ranges. 3 sec. (Max.) 20M range.

MAX INPUT PROTECTION: 1000V (DC + peak).

ENVIRONMENTAL

TEMPERATURE: Operating: 15°C to 35°C (58°F to 95°F).
Storage: — 25°C to 85°C (— 12°F to 185°F).

GENERAL

DISPLAY: 3½ digit, 7 segment L.E.D., Red, 0.4" segment.

INDICATORS: V, mV (Volts, milliVolts)
Automatic Polarity
Automatic Decimal
Automatic Overrange
(as blinking 1999 display)

SAMPLE RATE: 3.3 measurements per second.

MAXIMUM COMMON MODE VOLTAGE: 1500 volts (DC + peak).

FUSES: Line: 3AG 2/10 A
Resistance: 3AG 1/16A
Current: 3AG 2A

ELECTRICAL: All solid state circuitry, including CMOS LSI.

MECHANICAL: Vinyl covered steel case construction. Brushed aluminum handle also serves as tilt bail for bench use.

SIZE: 5.5" x 7.83" x 9.0" (hwd)
(14cm x 19.9cm x 22.9cm)

WEIGHT: 6.5 lbs. (3Kg).

POWER: 105 - 130VAC, 50-60Hz, 7 watts. (220VAC conversion available).

SUPPLIED ACCESSORIES: 39G91 Input Probe (with 200K Isolation Position) and Test Lead; Manual; Schematic and Parts List, and Instruction Tape.

OPTIONAL ACCESSORIES: HP200 50KV High Voltage Probe.

CONTROLS

1. PROBE: Insulated probe contains 200K ohm Isolation resistor and switch, and sharp probe point for positive contact.

2. INPUT TERMINALS: Two jacks are used for all functions and ranges.

3. FUNCTION BUTTONS: Large pushbuttons are provided for easy, error free selection of the desired function to be used — AC or DC Voltage or Current, or High or Low Power Resistance.

4. POLARITY: Indicator shows the polarity with respect to the black (—) lead potential.

5. DECIMAL: Indicator is automatically positioned.

6. DISPLAY READOUT: Uses bright L.E.D. seven - segment bars for easy viewing without eye fatigue.

7. V, mV: Indicator shows whether volt or millivolt scale is being displayed on 2V range.

8. RANGE BUTTONS: Selects range maximum reading to be obtained. Note that the two left and the right-hand buttons are Ohms ranges only. The remaining buttons are operational for volts, ohms, or mA.

9. NON—MAR FEET: Protect the bench surface or other instruments from scratches.

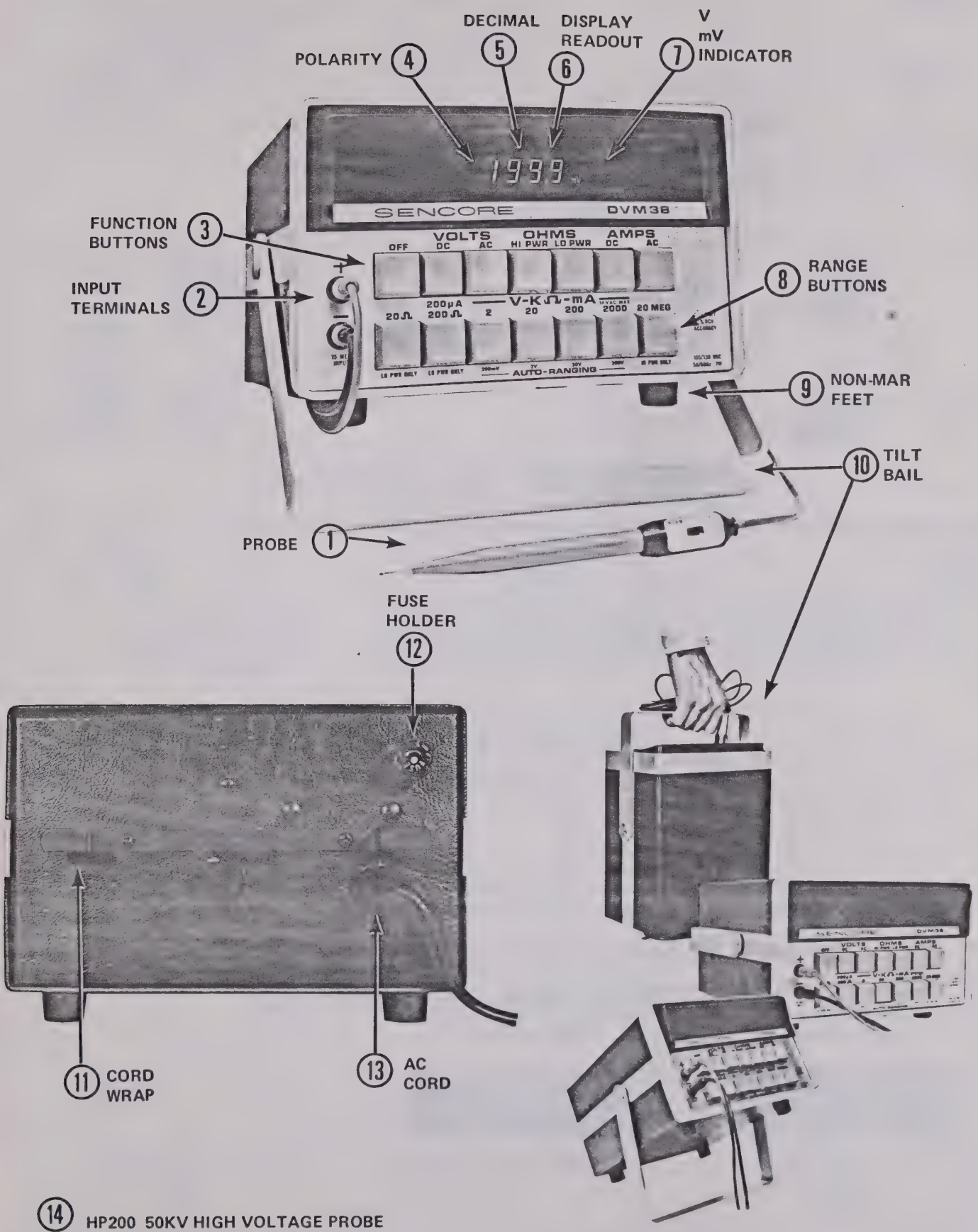
10. TILT—BAIL: Can be used to elevate the DVM up to 45° on the bench, as a handle for portable, or positioned behind the DVM on the shelf applications.

11. CORD WRAP: For storage of AC cord and test leads during portable use.

12. FUSE HOLDER: Contains ohms protection fuse (see Maintenance and Service Section).

13. AC CORD: To plug into three-prong grounded AC outlet. WARNING: Do not defeat the purpose of the grounding lug, as a dangerous shock hazard may result. Use a properly connected adaptor plug for use in a two prong outlet.

14. HV PROBE: HP200 50KV High Voltage Probe multiplies voltage readings by 100 for high voltage measurements.



14 HP200 50KV HIGH VOLTAGE PROBE

DVM38 FAMILIARIZATION

. . . the complete DVM

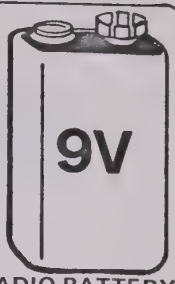
YOU WILL NEED:

DVM38 FAMILIARIZATION TAPE

PLUS

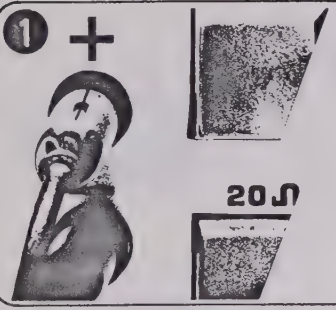
SENCORE DVM DEMONSTRATOR

OR



RADIO BATTERY

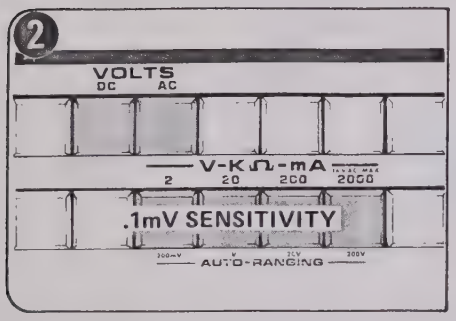
HIGH ACCURACY

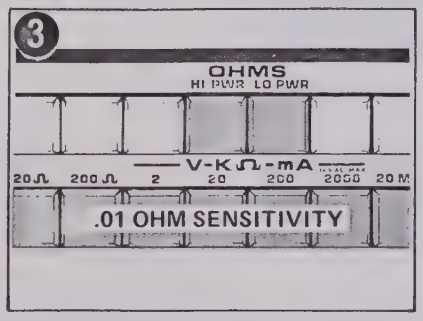


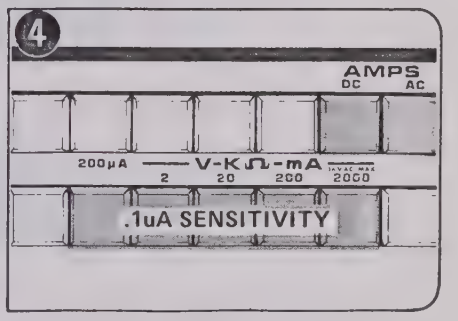
- 3½ DIGIT L.E.D.
- 1% DC ACCURACY
- 15 MEG INPUT
- LATEST CMOS LSI CIRCUITS

$3\frac{1}{2}$ DIGIT .1% DCV ACCURACY

VERSATILE MEASURING

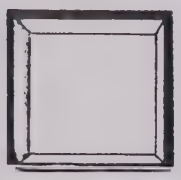




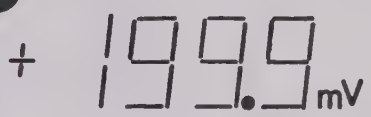


EASY TO USE

AUTOMATIC ZERO



BIG PUSHBUTTON OPERATION

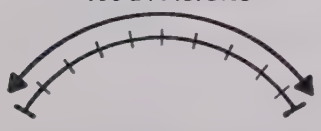


BIG READOUT WITH INDICATORS

PLUS OVERLOAD PROTECTION TO 2000 VDC, 1000V ON ALL OTHER FUNCTIONS.

RESOLUTION AND ACCURACY

100 DIVISIONS

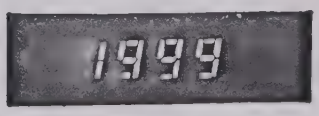


STANDARD METER SCALE CAN BE READ ACCURATELY
1 PART IN 100
1/100

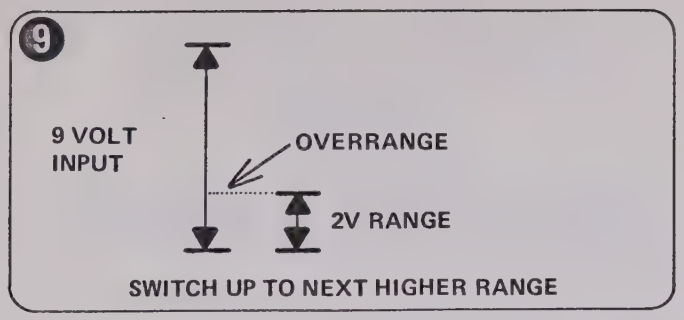
1000 DIVISIONS

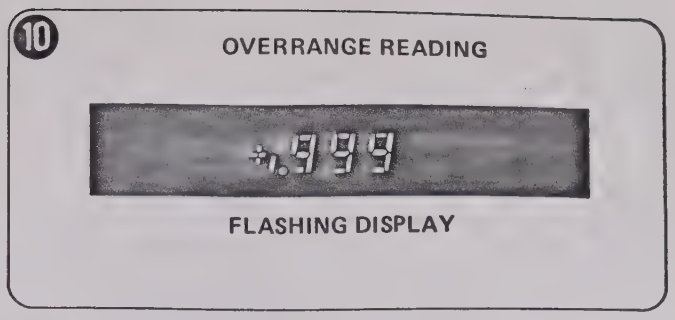
3–DIGIT DVM WILL READ TO
1 PART IN 1000
1/1000

2000 DIVISIONS

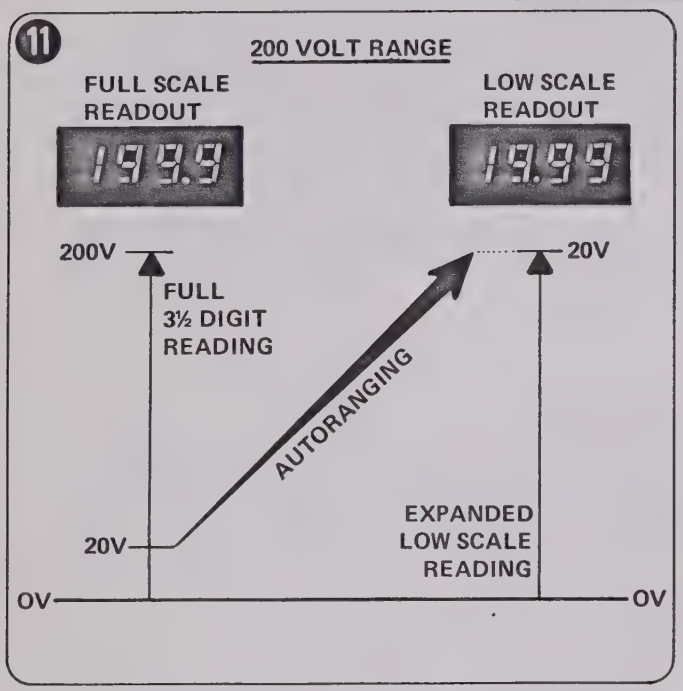


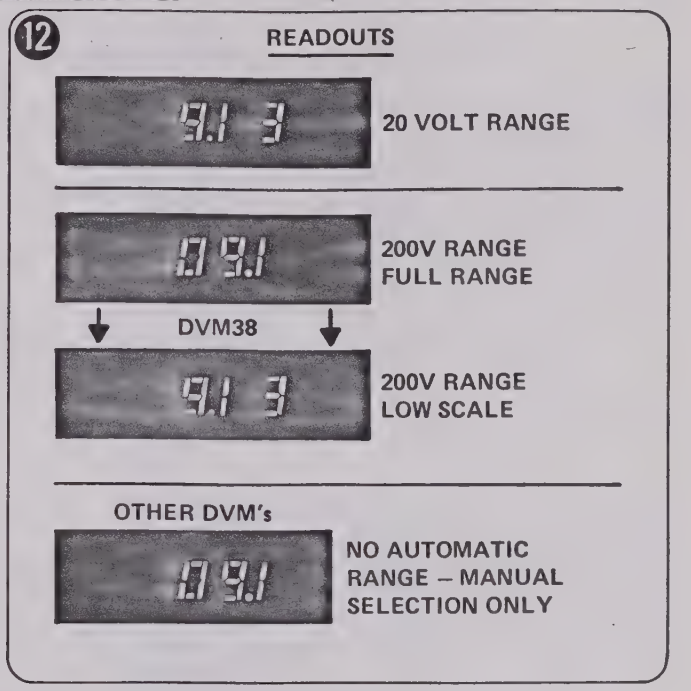
3½–DIGIT DVM WILL READ TO
1 PART IN 2000
1/2000



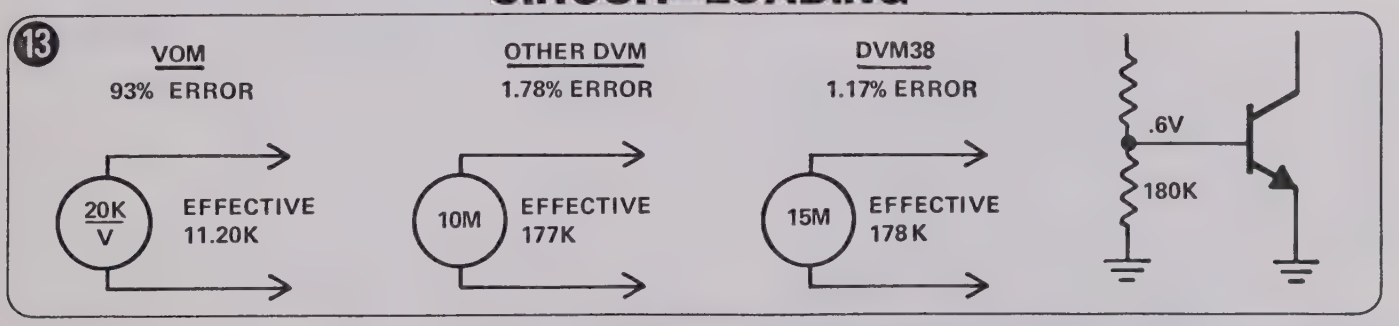


AUTO-RANGING

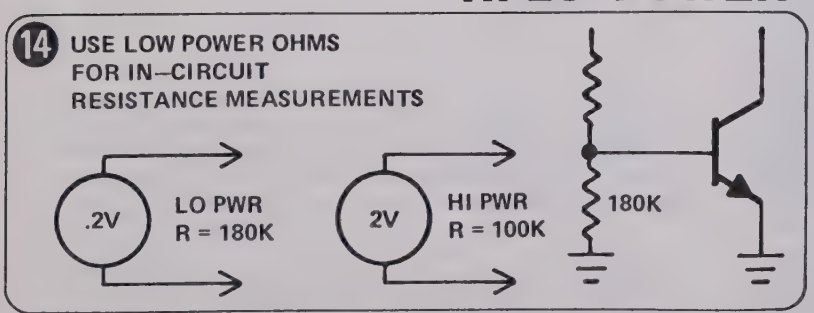


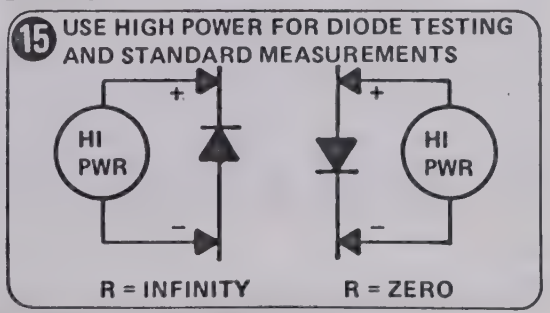


CIRCUIT LOADING



HI-LO POWER OHMS





READ THE OPERATION SECTION OF THE MANUAL FOR COMPLETE INFORMATION.

OPERATION AND APPLICATIONS

INTRODUCTION

To get maximum usefulness from your DVM38, you should become thoroughly familiar with its operation and applications before putting the instrument to use. Play the Familiarization Tape supplied with the DVM38, then read through the step-by-step instructions in this Operation Section, and the instructions for common DVM applications and uses.

Observe all safety precautions listed inside the front cover and throughout the manual to insure continued usefulness with the DVM38.

OVERLOAD PROTECTION

The DVM38 is a completely protected digital multimeter, eliminating meter downtime because of accidental overloads. Built-in circuit overload protection reduces time consuming fuse replacement for the most common errors. Additional fuse protection prevents damage during heavy overloads.

All function and ranges of the DVM38 are protected, as follows:

OVERLOAD PROTECTION LIMITS

FUNCTION	OVERLOAD LIMIT	PROTECTION
DC Voltage	2000V (DC + peak)	Diode, Hi Input Impedance
AC Voltage	1000V (Peak + DC)	Diode, Hi Input Impedance
DC, AC Current	2A RMS	Diode, 2A Fuse
Resistance	1000V (Peak + DC)	Diode, neon bulb, 1/16A Fuse
AC Line Power		.2A Fuse

The protection will generally handle an overload long enough for corrective action to be taken. With any overload the display will indicate a flashing "1999" overrange condition. Remove the probe from the test point, select the proper function and/or range, then make the test again.

Always start at the highest range when measuring unknown voltages. Switch down to the range giving the greatest accuracy once the approximate value is known.

See the Maintenance and Service Section for fuse replacement instructions.

> CAUTION: DO NOT EXCEED THE OVERLOAD LIMITS. To do so may cause damage to the instrument and possible hazards to the operator. The warranty is invalid if an instrument shows indications of overload.

PREPARING FOR MEASUREMENT

1. With the DVM38 in the "OFF" position, plug the AC cord into any 105-130VAC, 50-60Hz outlet.

> WARNING: Do not defeat the purpose of the AC grounding lug, as a dangerous shock hazard may result. Use a properly connected adaptor plug for use in a two prong outlet.

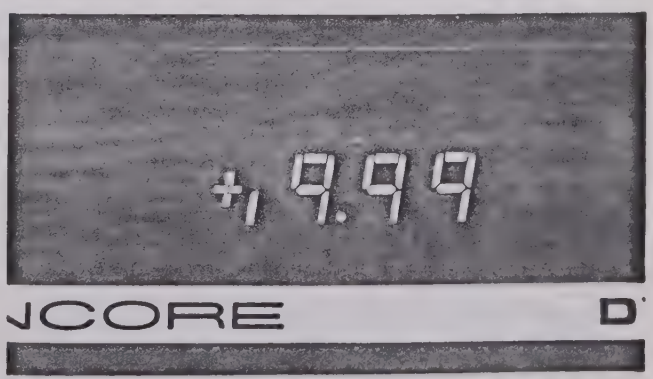
2. Turn the unit on by selecting the desired FUNCTION and RANGE pushbuttons.

3. Set the Probe Isolation Switch to NORM position.

4. With the Test Leads shorted, the display should read "000." No zeroing adjustment is needed because of the automatic zeroing circuitry. Note: The last digit may change from "0" to "1", and is a normal action. The polarity sign may alternate between "+" and "—" on DC voltage or current.

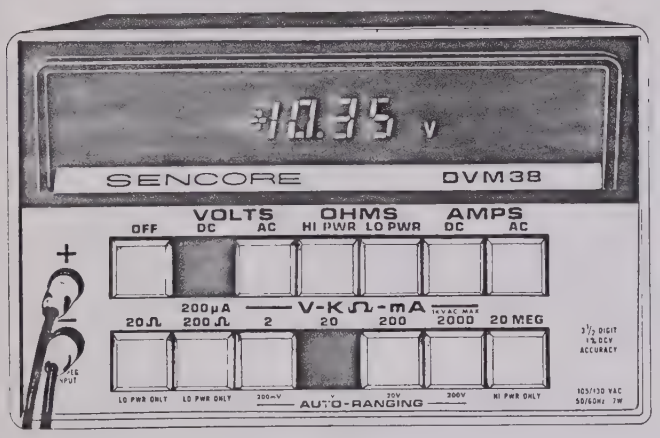
OVERRANGE INDICATION

If the actual measured value on any range or function is above the maximum value of the selected range (such as measuring 28VDC on the 20V range), the DVM38 will display a blinking "1999" to indicate the overrange condition. Only the lower half of the "1" will be lit in overrange, however, to avoid confusion with a normal 1.999 measurement. Step up to the next higher range until a normal reading is obtained. Infinity resistance (open circuit) will always show as overrange on any OHMS range.

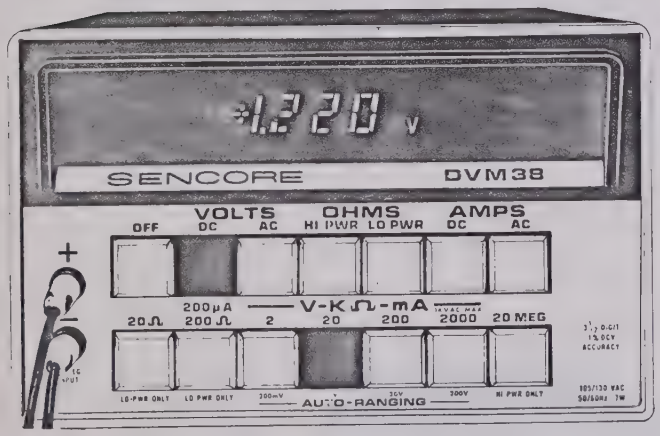


AUTO-RANGE

The DVM38 Auto-Ranging feature "steps-down" the range to obtain full 3½ digit resolution in the lower 10% of each DC/AC voltage range. A conventional 3½ digit multimeter will limit the readout to 2½ digit resolution in the lower 10% of range. For example, 10.45V would be read as 10.5V on the 200V range. The DVM38 will automatically increase the Lower Scale sensitivity ten times for any voltage measurement less than 10% of full range (giving the full readout of 10.45).



20V HIGH SCALE



20V LOW SCALE

As a result, the resolution accuracy is increased ten times at the low end of each voltage range. Time consuming manual selection of ranges is also reduced. For example, any voltage from 0.01 to 200.0V can be measured on the 200V range.

The following chart shows the resolution limits for each range, and illustrates circuits where the range will display nearly all the voltages used without switching to other ranges.

SELECTED RANGE	"STEP-DOWN" SCALE	RESOLUTION	CIRCUIT USE
2000V	200.0V	100mV	Tube
200V	20.00V	10mV	Solid State
20V	2.000V	1mV	I.C.
2V	200.0mV	.1mV	RF, Low Level Amps

For greatest resolution, the ranges should be selected so that three or four digits are lit when a measurement is being made. The decimal will be automatically positioned on the display for the range selected.

DC VOLTAGE MEASUREMENT

1. Make the initial set-up as explained in PREPARING FOR MEASUREMENT. Be sure the Probe Isolation switch is in the NORM position, unless isolation is needed in high frequency circuits.

2. Press the VOLTS — DC pushbutton.

3. Press the Range pushbutton required for the voltage to be measured. If the value of the voltage is unknown, start with the 2000V range and work down to the range required for a satisfactory reading.

4. Connect the common lead to the ground or common point of the circuit in which the measurements are to be made.

5. Touch the Test Probe to the voltage point to be measured. The instrument will automatically determine the polarity and display either "+" or "—", and the voltage measured. If the voltage is over the range selected the overrange indication of a flashing "1999" will be displayed.

6. The "mV" indicator will light when the measured reading is in milliVolts (on lower 2V range). Otherwise, the "V" Volts indicator will be lit.

AC VOLTAGE MEASUREMENT

1. Make the initial set-up as explained in PREPARING FOR MEASUREMENT. Be sure the Probe Isolation switch is in the NORM position.

2. Press the VOLTS — AC pushbutton.

3. Press the Range pushbutton required for the voltage to be measured. If the value of the voltage is unknown, start with the 1000V range and work down to the range required for a satisfactory reading.

4. Connect the Test Lead and Probe to the voltage points to be measured. There is no polarity indication when measuring AC Volts.

5. The "mV" indicator will light when the measured reading is in milliVolts (on the lower 2V range).

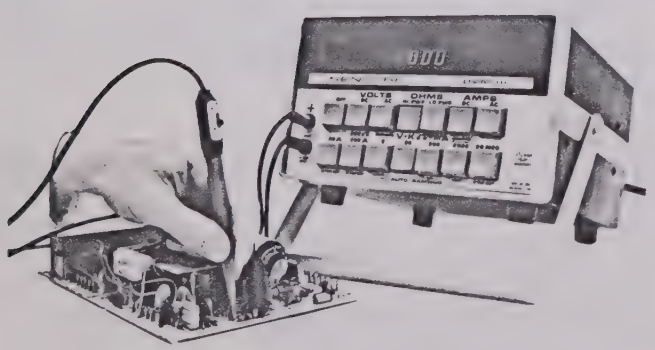
NOTE: The AC converter detects the AC average value, but displays the RMS value for a pure sine wave. Readings obtained for non-sinusoidal waveforms may not be the true RMS value.

SELECTING HI POWER OR LO POWER OHMS

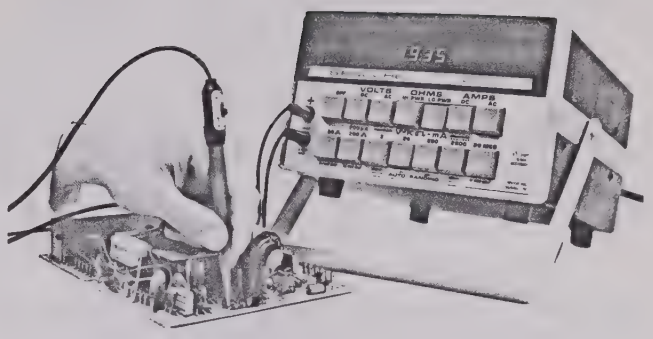
The DVM38 Lo Power Ohms function allows in-circuit resistance measurements in solid state circuits. Most multimeters use a 1.5 volt, or greater, source voltage at the test leads. This voltage causes semiconductor components to conduct, giving erroneous resistance readings. Lo Power Ohms uses a much lower source voltage (.2V max.) that will not cause forward junction conduction. The need for switching the test leads to obtain the "correct" reverse bias reading is eliminated.

Select Lo Power Ohms when making resistance measurements in-circuit. Hi Power Ohms is used for most standard resistance measurements. The current through unknown resistances is always maintained at low levels to prevent damage to delicate solid state components.

NOTE: The 20 and 200 ohm ranges are LO PWR only. Selecting the HI PWR function button on these ranges will internally short the ohms measuring circuit. A "000" resistance reading will be obtained. As a simple check for proper operation, be sure that the readout is a blinking "1999" overrange with the test leads open.



HI POWER IN CIRCUIT RESISTANCE READING



LO POWER IN CIRCUIT RESISTANCE READING

RESISTANCE MEASUREMENT

1. Make the initial set-up as explained in PREPARING MEASUREMENT. Be sure the Probe Isolation switch is in the NORM position.

2. Press either the OHMS - HI PWR or LO PWR button, as desired. No meter zero adjustment is needed because of the automatic zero circuits. The display will indicate infinity resistance overrange (blinking "1999") with no input.

3. Press the Range pushbutton required for the resistance to be measured.

   NOTE: The 20 and 200 ohm ranges are LO PWR only, and the 20 megohm range is HI PWR only. The remaining four ranges may be selected for either HI or LO PWR.

4. REMOVE POWER from the equipment in which the measurement is to be taken and DISCHARGE electrolytic capacitors.

5. Connect the test leads across the resistance to be measured. If the resistance value exceeds the range selected, the overrange indication of a blinking "1999" reading will be present.

NOTE: The DVM38 will not "zero" on the 20 ohm range because the high sensitivity ohms circuit measures the lead and contact resistance within the instrument. An indication of .30 to .34 ohms is typical. This should be subtracted from the reading obtained on this range in critical measurements. A "003" reading (± one digit) on the 200 ohm range is also normal.

This internal resistance does not affect the other resistance ranges. See "Measuring Low Resistances" for additional information.

DC CURRENT MEASUREMENT

1. Make the initial set-up as explained in PREPARING FOR MEASUREMENT. Be sure the Probe Isolation switch is in the NORM position.

2. Press the AMPS — DC pushbutton.

3. Press the Range pushbutton required for the current to be measured. If the current value is unknown, start with the 2000mA range and work down to the range required for a satisfactory reading.

4. Before connecting the instrument to read DC current, always REMOVE POWER from the equipment in which the current is to be measured.

5. Always connect the meter leads in series with the circuit to measure current. Break the circuit between the power source and the load, then connect the test leads to each terminal of the open circuit. The display will automatically indicate "+" or "—" current with respect to the black lead.

6. The life of the pushbutton switches can be prolonged if switching high currents is avoided. When using the high ranges, turn the power off in the circuit to be measured before switching the DVM38 range.

AC CURRENT MEASUREMENT

1. Make the initial set-up as explained in PREPARING FOR MEASUREMENT. Be sure the Probe Isolation switch is in the NORM position.

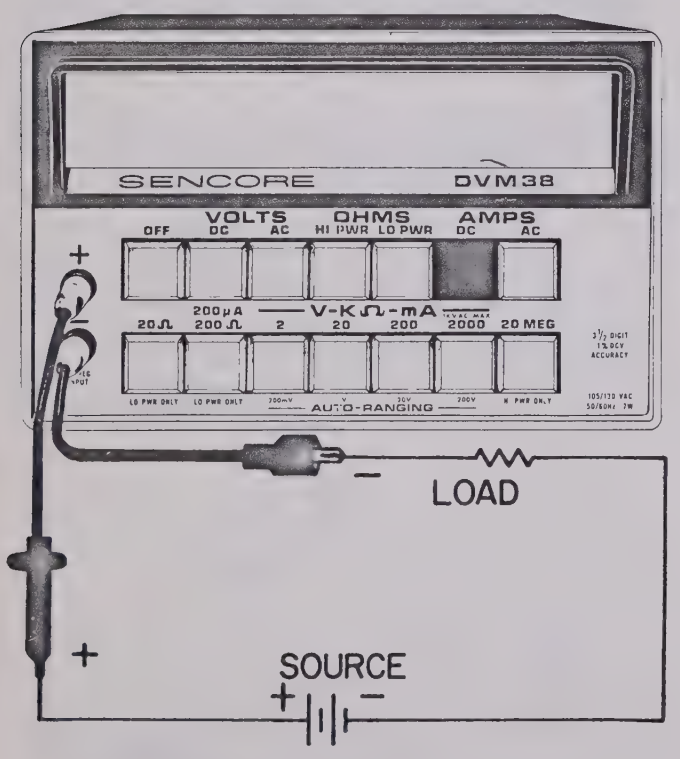
2. Press the AMPS — AC pushbutton.

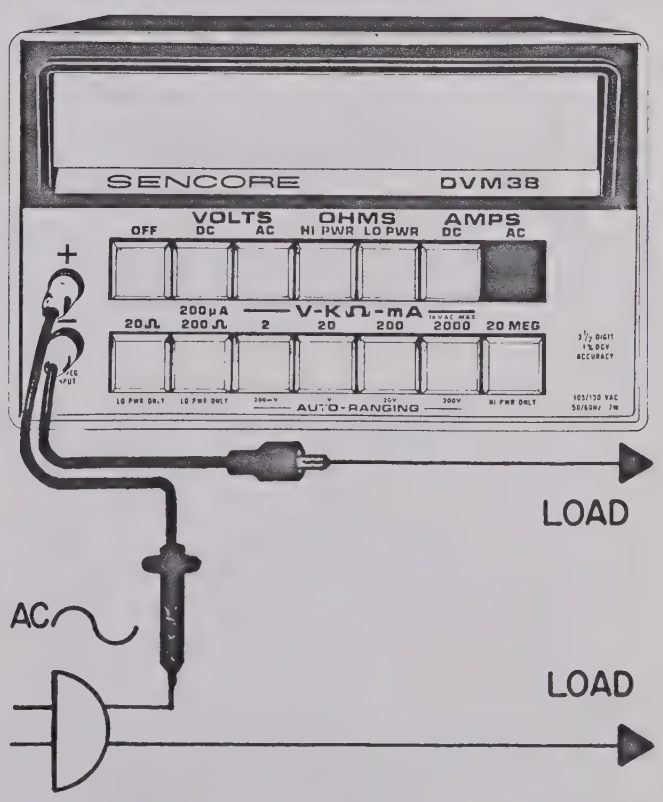
3. Press the Range pushbutton required for the current to be measured. If the current value is unknown, start with the 2000mA range and work down to the range required for a satisfactory reading.

4. Before connecting the instrument to read AC current, always REMOVE POWER from the equipment in which the current is to be measured.

5. To measure current, always connect the meter leads in series with the circuit. Break the circuit between the power source and the load, then connect the test leads to each terminal of the open circuit. There is no polarity indication when measuring AC current.

6. The life of the pushbutton switches can be prolonged if switching high currents is avoided. When using the high ranges, turn the power off in the circuit to be measured before switching the DVM38 range.





CONNECTING COMMON ABOVE GROUND

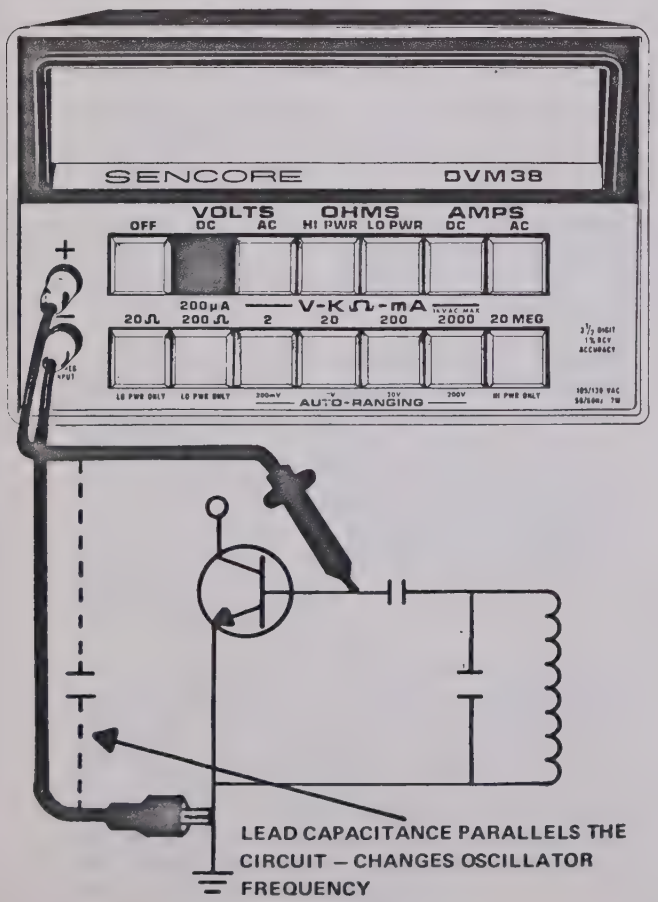
The DVM38 may be operated with the common (—) lead connected to a potential up to 1500V (DC + Peak) above chassis ground. To prevent a safety hazard to the operator and damage to the equipment, this value must not be exceeded.

> WARNING! Do not connect the DVM38 common (—) lead to any voltage of more than 1500V (DC + Peak) above chassis ground.

DC VOLTAGE MEASUREMENTS WITH ISOLATION

DC voltage measurements made in high frequency or low signal level circuits may disrupt normal circuit operation, and cause erroneous and misleading readings. Consider a high frequency oscillator circuit where the DVM test lead is connected across the resonant circuit. The test lead capacitance parallels the circuit capacitance, possibly changing the oscillator frequency enough to stop the circuit operation.

The Probe Isolation switch connects the 200K ohm resistor in the probe in series with the lead. This resistor effectively isolates the DVM input capacitance from the circuit by terminating the probe at the tip. Normal circuit operation and accurate measurements can be maintained.



> NOTE: Use of the Probe Isolation resistor will eliminate this large error, but will introduce a lower reading error of up to 1.3%, since the isolation resistor is in series with the DVM input impedance. Isolation should only be used when the NORM position results in an erroneous reading. This will maintain accuracy of the instrument readings when isolation is not needed.

When isolation is required, place the Probe switch in 200K ISOLATION position, and proceed as described in the DC VOLTAGE MEASUREMENT Section.

INCREASING INPUT IMPEDANCE

The 15 megohm input impedance of the DVM38 is high enough to prevent it from loading most circuits. As a general rule, the input impedance should always be at least 10 times that of the circuit being measured. The DVM38 will measure voltages in circuits up to 1.5 megohms without appreciable circuit loading. In comparison, other DVMs or VTVMs are limited to 1 megohm circuits without appreciable loading.

If it is desired to measure the voltage in an extremely high impedance circuit, use the optional HP200 50Kv High Voltage Probe as an isolation resistor. This probe will drop all DC voltage readings by a factor of 100. The input impedance is increased by 100 times, giving a total input impedance of 1500 megohms.

The HP200 converts the 200mV scale to a 20V full scale range. This range allows voltages as low as .01V to be measured with the extremely high input impedance.

> NOTE: The 1% resistor used in the HP200 combined with the .1% accuracy of the DVM38 will still provide good accuracy for such readings.

Slip the HP200 Probe over the Test Probe, making sure the probe tip is secured in the HP200. Select the range desired and multiply the readout by 100 to obtain the measured voltage.

HIGH VOLTAGE MEASUREMENTS

> WARNING! Do not measure over 2000V directly with the DVM38 test leads. Severe damage to the DVM38 and equipment, and possible shock hazard to the operator, may result. Make high voltage measurements with the Sencore HP200 50Kv High Voltage Probe only.

The Sencore HP200 50Kv High Voltage Probe extends the DC Voltage capability of the DVM38 to 50Kv DC. This probe must be used with the DVM38 for high voltage measurements above 2000V DC. The probe acts as a voltage dropping resistor that reduces the

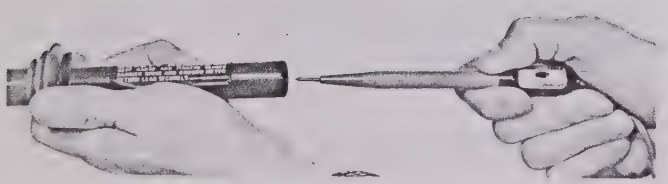
voltage at the input terminals to 1/100 of the measured potential. The DVM38 readout must be multiplied by 100 to obtain the value of the voltage to be measured, within 1% accuracy.

NOTE: Read this section entirely before proceeding with the test.

1. REMOVE POWER from the equipment in which the high voltage is to be measured.

2. Be sure the DVM38 Test Probe is plugged into the (+) jack very securely.

3. Plug the DVM38 Test Probe into the back of the HP200 HV Probe. Be sure that the probe tip is securely seated.



4. Select the VOLTS — DC Function pushbutton and the 2000V Range button.

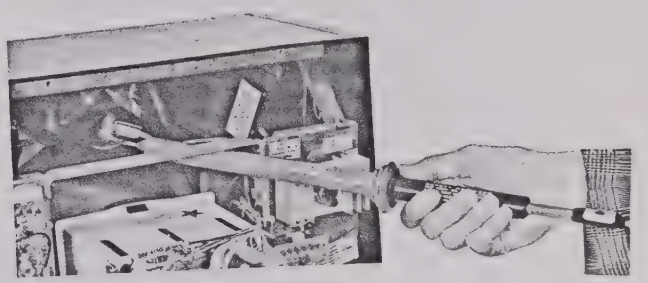
5. SECURELY ATTACH the black common lead from the DVM38 to the ground, chassis, or common point of the high voltage circuit to be measured. Be sure that this lead cannot become detached during the high voltage measurement.

   CAUTION! If the common lead becomes detached during the measurement, a SEVERE SHOCK HAZARD will be present. DO NOT TOUCH the DVM38 or HV Probe! Immediately REMOVE POWER from the equipment in which the high voltage is being measured. Then remove the HV Probe from the equipment. Damage to the DVM38 may have resulted, since it would effectively be at the high voltage potential.

   CAUTION! Should the positive banana jack become disconnected from the DVM38 during high voltage measurement, DO NOT TOUCH the probe lead or banana plug. Immediately REMOVE POWER from the equipment in which the high voltage is present. Disconnect the HV Probe first from the equipment, then reconnect the probe banana plug to the DVM38 jack.

6. Connect the high voltage probe to the high voltage point to be measured, so that the probe DOES NOT have to be held in the hand during meaurement.

   CAUTION! If the HV Probe MUST be held on the high voltage point during measurement, be sure to keep one hand in your pocket and stand on dry, insulated material. Hold the probe ONLY BY THE BLACK HANDLE portion.



7. Apply power to the equipment in which the high voltage to be measured is present.

8. Multiply the readout by 100 to obtain the value of the high voltage being measured, or simply add two zeroes to the reading. For example, if the readout is 300, multiply 300 x 100 for the value of 30,000 Volts being measured.

9. REMOVE POWER from the equipment being measured and detach the HV Probe and common lead.

MEASURING LOW RESISTANCES

The DVM38 20 and 200 ohm ranges extend DVM accuracy to extremely low resistance measurements. Current - limiting resistors of less than one ohm, meter shunts, motor windings, fuses, and electrical contact resistances can be measured quickly and accurately.

Because of the high sensitivity ohms circuit, the DVM38 measures its own internal lead, fuse, and switch contact resistance. Therefore, readings of "0.30" to "0.34" ohms are normal on the 20 ohm range, as is a "00.3" reading on the 200 ohm range. The specification accuracy is maintained throughout the range since the unknown resistance is series connected to the internal resistance. When using these ranges, note the reading with the test leads shorted. Then make the measurement and subtract the shorted lead reading.

To avoid erroneous readings and to improve repeatability, the following precautions should be taken when making low resistance checks:

1. Check the banana jacks at the DVM38 Input Terminals for good contact. They should not be oxidized or corroded.

2. Don't touch the exposed leads during the measurement since stray AC pick-up may cause interference.

3. Make sure the Test Probe and ground clip make good contact to clean metal surfaces. It may be necessary to scratch dull, oxidized surfaces until they are bright and shiny. Poor contact will cause the DVM38 reading to change more than 2 or 3 digits.

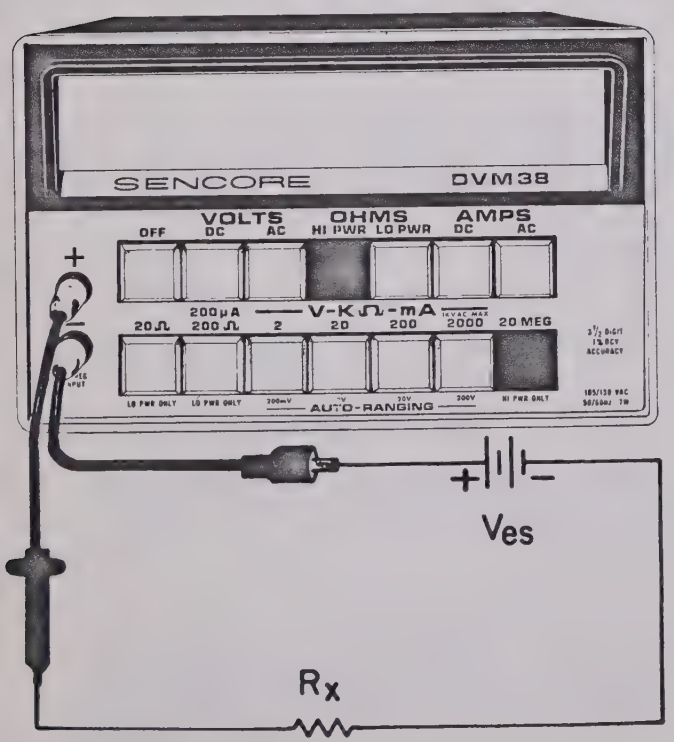
HIGH RESISTANCE MEASUREMENT

High resistances over 20 megohms may be measured with the DVM38 by using this procedure to obtain a reading. The accuracy of this measurement depends upon the stability of the external voltage source.

1. Measure and record the external source voltage, V_{es}.

2. Select the HI PWR Function and the 20 megohm Range.

3. Connect the equipment as shown. Do not touch the probe and lead tips during measurement since body skin resistance will affect the readings.



4. Record the reading after it has stabilized (approximately 30-60 seconds for most readings).

   NOTE: Fastest results will be obtained by approximating the required voltage for a "10.00" reading using the formula below before the test is made, if the unknown resistance can be estimated.

   Highly erratic readings indicate the external voltage is too high, while overrange "19.99" indicates the voltage is too low.

5. Determine the unknown resistance (in megohms) from this equation:

   $R_X = 10 \cdot V_{es} + D$

   Where R_X = Unknown resistance (in megohms)

   V_{es} = External source voltage

   D = Display readout

USING SERVICE LITERATURE RESISTANCE TABLES

Many types of servicing literature include resistance charts showing the resistance paths to ground from key test points. These charts can be helpful in locating defective solid state devices. However, it is necessary to determine whether the chart was prepared with a Hi or Lo Power Meter. See the section SELECTING HI POWER OR LO POWER OHMS.

Generally, if no special reference is made, the Hi Power function of the DVM38 should obtain the same readings. If the chart refers to a source voltage of less than .1 volts, the Lo Power ohms function should be used.

RESISTANCE MEASUREMENTS

MEASUREMENTS BELOW TAKEN WITH METER HAVING .08V MAX BETWEEN PROBE TIPS

ITEM	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 11	PIN 12	PIN 13	PIN 14
V101	35 M	NC	27 K	NC	NC	FIL	FIL	27 K	33 K	4 M	NC	27 K	NC	
IC400	33 K	3000	8200	45 K	0	1600	INF	INF	2000	2000	2000	360	9000 PIN 15 60 K	360 PIN 16 33 K
IC401	9000	900	900	1550	0	5700	1200	1200	INF	750	37 K	37 K	700 K PIN 15 33 K	700 K PIN 16 33 K
IC500	INF	INF	0	0	700	12 K	8500	INF	5400	5400	INF	11 K	5700	90 K
IC1000	INF ƒ	360	0											
IC1001	51	750	43 K											

ITEM	E	B	C		ITEM	E	B	C		ITEM	E	B	C	
Q100	39	12 K	60 K ƒ		Q304	95 K	90 K	570		Q703	1000	1800	0	
Q101	INF	INF	INF ƒ		Q305	95 K	2200	5600		Q704	1500	3000	23 K ƒ	
Q102	INF	INF	INF ƒ		Q400	360	2500	1650		Q705	1500	3000	23 K ƒ	
Q103	.2	1.5	45 K ƒ		Q401	0	25 K	3600		Q706	1500	3000	23 K	
Q105	.68	1500	INF		Q402	0	15 K	6200		Q707	680	200	1500	
Q106	INF	INF	INF		Q500	470	9000	770		Q708	680	50	1500	
Q200	390	90 K	1500		Q600	INF	INF ƒ	40 K		Q709	680	40	1500	
Q201	1000	4000	1600		Q601	0	54 K	INF		Q710	0	90 K	INF ƒ	
Q202	300	900	770		Q602	5600	INF	INF		Q711	0	15 K ƒ	INF ƒ	
Q203	680	4000	850		Q603	0	5600	INF		Q800	380	30 K	50 K ƒ	
Q204	330	680	1600		Q604	INF	INF	INF		Q801	470	3900	53 K ƒ	

CHECKING TRANSISTORS AND DIODES

Front to back ratios of diode and transistor junctions can be measured using the DVM38 HI PWR OHMS function. Normal reverse junction bias will indicate as a blinking overrange on any range. With forward junction bias the DVM38 will not show the "zero" reading typical of analog meters on this test. The DVM38 will instead indicate the approximate voltage drop across the junction.

This reading (ignoring the decimal position) can be used to determine the junction material. Silicon material will generally show as "600" or more (.6V), and germanium will give a reading of about "300" (.3V).

These readings will depend upon the particular ohms range (drive current) used. The 2K ohms range is best for this test since the highest current level is used. This current is still limited to a very low level and will not damage solid state components.

For determining polarity, the DVM38 (+) lead is positive, and the black lead is negative.

HIGH CURRENT MEASUREMENTS

When measuring current above 1 Amp, the resistance in the test lead contact points may be critical and cause erratic readings. The following precautions should be used to insure accurate measurements.

1. The banana jack must have good contact to the DVM38 input terminals. It may be necessary to spread the small spring contacts with a small screwdriver to restore adequate tension.

2. If the jack or plug surfaces have developed corrosion or dull oxidation, they should be cleaned, or the plug replaced.

3. Be sure the ground lead clip and test point make good contact.

4. Proceed with the measurement as explained in DC OR AC CURRENT MEASUREMENTS.

MEASURING CURRENT OVER 2 AMPS

The DVM38 will measure higher currents above 2 Amps (up to 20 Amps) with an external current shunt. Instructions for constructing the shunt are given following these operating instructions.

1. Connect the shunt between the DVM Input Terminals.

2. Press the VOLTS — DC or AC pushbutton, as required, for DC or AC current.

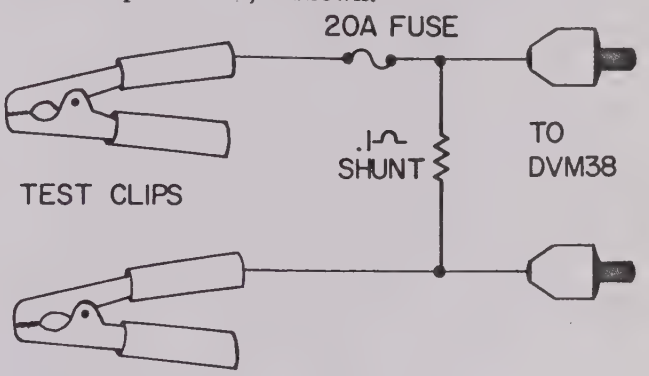
3. Press the 2V Range pushbutton.

4. Before connecting the instrument to read the current, always REMOVE POWER from the equipment in which the current is to be measured.

5. Always connect the meter leads in series with the circuits to measure current. Break the circuit between the power source and the load, then connect the test leads to each terminal of the open circuit.

6. Apply power to the circuit for the current reading. Multiply the readout by ten for the actual current in Amps (Example: 1.000 reading indicates 10.00 Amps).

The shunt can be assembled using locally purchased parts. It must have a total resistance of .1 ohm, and be constructed to carry the maximum of 20 Amps. It may be assembled from either 15'8" of No. 18 AWG copper wire or 7 - 7/8" of No. 20 gage resistance wire (Alloy 45) (Sencore part No. 42E11 - $.75). Resistance wire will not change value as the shunt temperature increases. A 20 Amp fast blow fuse may be connected in series with the shunt for overload protection, as shown.

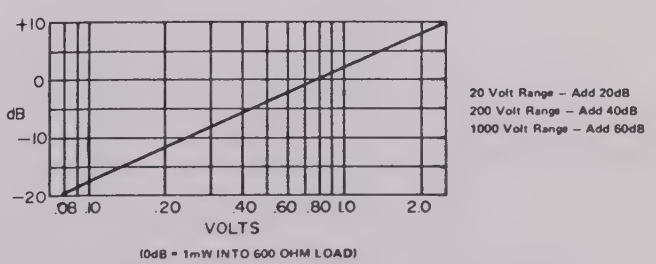


Use heavy test clips and connectors to insure proper current carrying capability. Allow adequate ventilation for the heat dissipated from the shunt, if more than momentary measurements are made.

dB CONVERSION

The DVM38 may be used for gain and accuracy measurements with the use of the decibel (dB) conversion chart below. The dB is the logarithm of the ratio of two signals. In audio, the measured signal is compared to the fixed reference (0 dB) of 1 milliwatt into a 600 ohm load, equivalent to 775 milliVolts.

Measure the signal with the DVM38, then use this chart to convert to decibels.



USE AS A NULL DETECTOR

The DVM38 can be used as a high resolution null detector, because of the automatic polarity indication and 10 milliVolt resolution. Small voltage differences can be detected in bridge circuits, potentiometers, difference amplifiers, etc. Simply adjust the circuit for an all zero reading on the DVM38 200mV scale. Any null change will be indicated by polarity and amplitude.

READING THE DISPLAY IN DIRECT SUNLIGHT

If the DVM38 display is exposed to direct sunlight, or other intense light conditions, it will appear to indicate "+1888" because of reflected light on the L.E.D. segments. Simply shade the readouts, or turn the instrument so the built-in bezel shades the display.

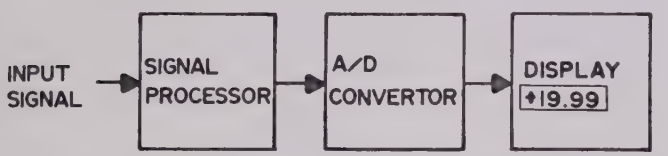
CIRCUIT DESCRIPTION

INTRODUCTION

This section describes the theory of operation of the DVM38. Simplified diagrams and descriptions are included for a basic understanding of the functions and operations of each circuit. These will be helpful in learning how your DVM38 operates and will serve as a guide to the calibration and maintenance of the instrument.

THEORY OF OPERATION

Three main circuit functions must be performed by the DVM38 on each measurement for it to be viewed as the digital display.

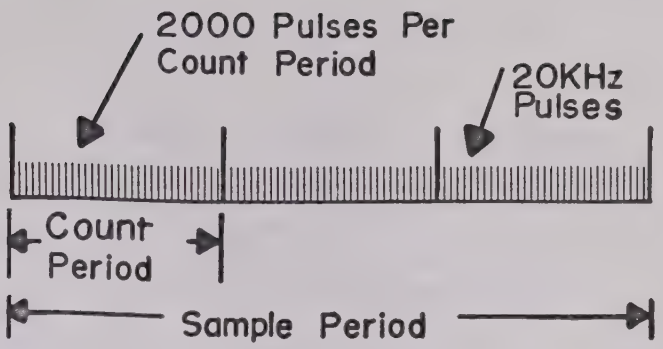


The Signal Processor Section converts the input signal to a DC Voltage that is suitable to drive the Analog to Digital (A/D) Converter. The Converter produces the digital coding that operates the Display Section to produce the digital readout.

The Signal Processor includes the Function and Range switches to select the operation to be performed on the input signal. The DC inputs are dropped to their proper level by range voltage dividers and current shunts. An AC to DC Converter rectifies and filters all AC signal inputs. The Hi and Lo Power Ohms circuits produce a DC output voltage proportionate to the unknown resistance. The Processor output is a ± 0 - 2VDC analog input used by the A/D Converter.

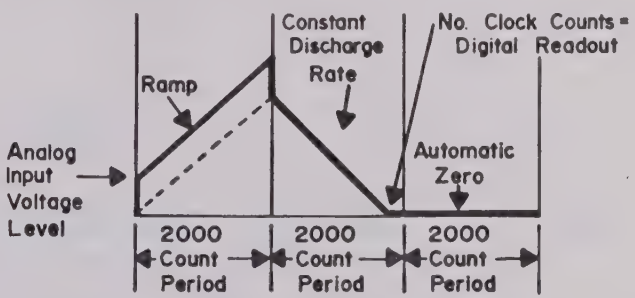
The heart of the DVM38 is the MN2301 LSI IC chip which converts the ± 0 - 2VDC analog input voltage to the digitally coded outputs that will give the proper display readout of the measured signal.

This A/D Converter uses the dual slope method of converting the analog input to the binary coded data (BCD) for the display circuits. IC207 receives a 160KHz signal from the Clock circuit and divides these pulses by eight. The 20KHz pulses are then counted to three 2000 count periods for one sample period.



The first count period integrates, or ramps, the analog input voltage. The slope of this ramp, and hence the peak point of the ramp, varies directly with the amount of the input voltage.

The averaging during this ramp time reduces noise and transient interference. During the second count period, the integrated input is reduced to zero at a constant discharge rate. The time (number of clock counts) required for this to occur is proportionate to the input voltage. The Analog to Digital Converter produces the number of the counts in the discharge period as the coded data output for the display. The third count period has no signals applied and is used to set the Auto Zeroing circuitry within IC207.



The A/D Converter IC also provides outputs for the Automatic Polarity and Auto Ranging features.

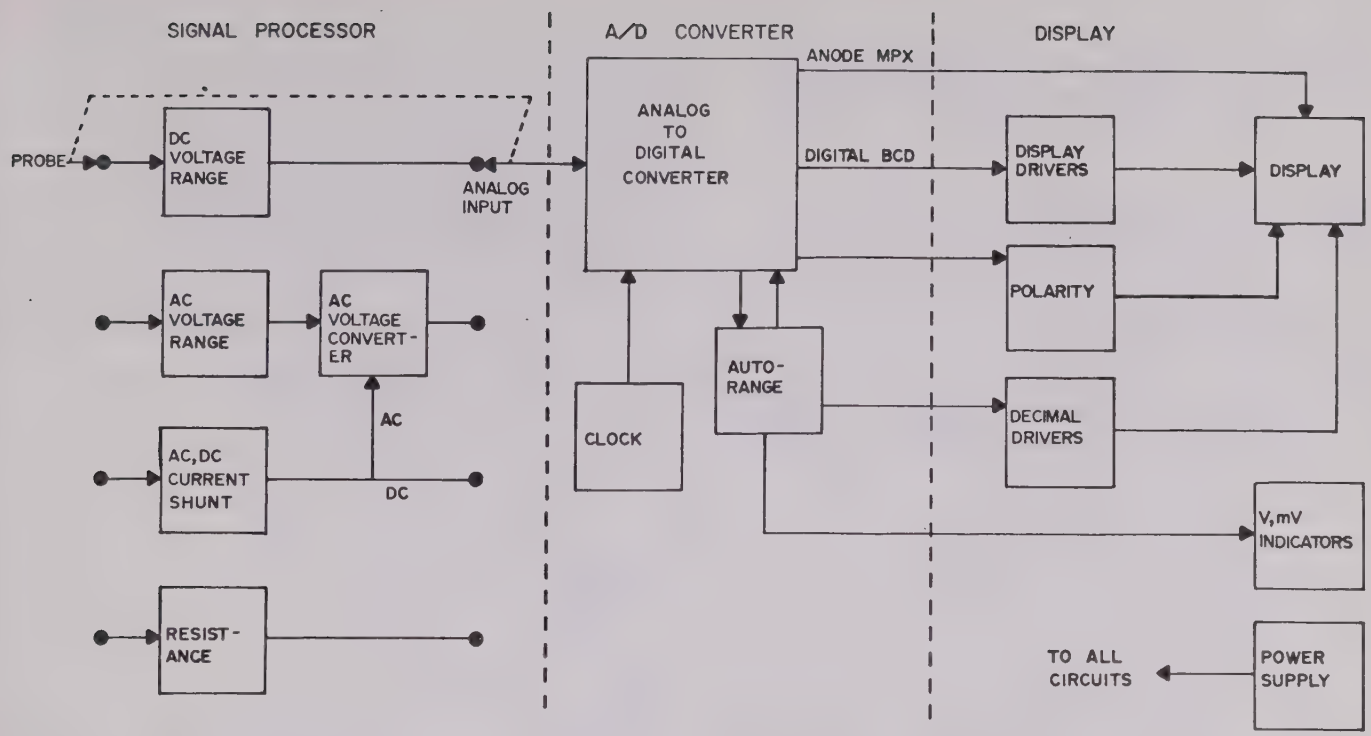
The Display Section converts the BCD output to a decimal output and presents the decoded information on seven segment L.E.D. (Light Emitting Diode) readouts. The Display, Polarity, and Decimal Driver circuits accomplish the decoding process.

The result is an extremely accurate and clearly readable presentation of the measured signal.

BLOCK DIAGRAM AND CIRCUIT DESCRIPTION

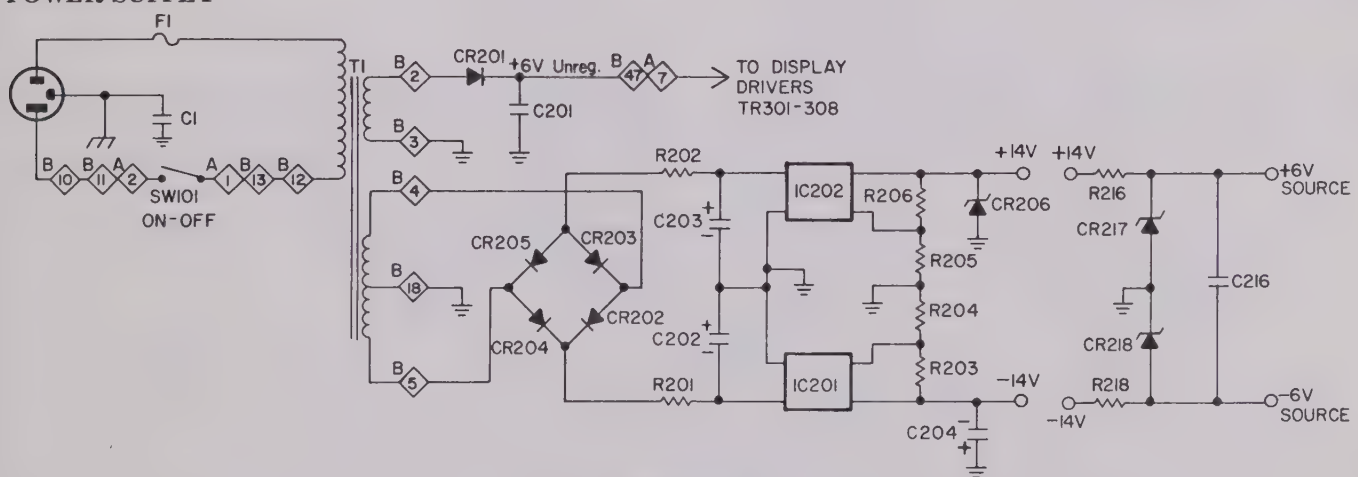
Following is the complete DVM38 Block Diagram, and simplified schematics and descriptions for each circuit.

All the function selection components are mounted on the Function (or "A") Board. These components are always prefixed with a 100 number in the circuit

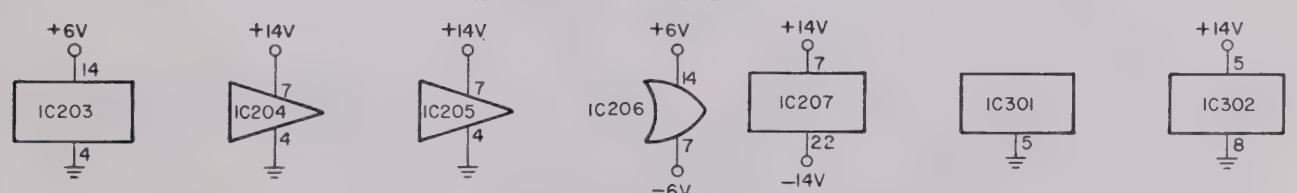


reference. Likewise, most Display components are on the Display ("C") Board and have a 300 prefix. All remaining circuits, including the Range Selector, Signal Processor, Clock, A/D Converter, and Decimal Drivers, are on the Range ("B") Board. These components carry a 200 schematic prefix. Chassis mounted components have no prefix.

POWER SUPPLY



IC POWER CONNECTIONS



The Power Supply provides four regulated and one unregulated output to power all DVM38 circuitry.

The AC power line is transformer isolated and fuse protected from the stepped down secondary circuits.

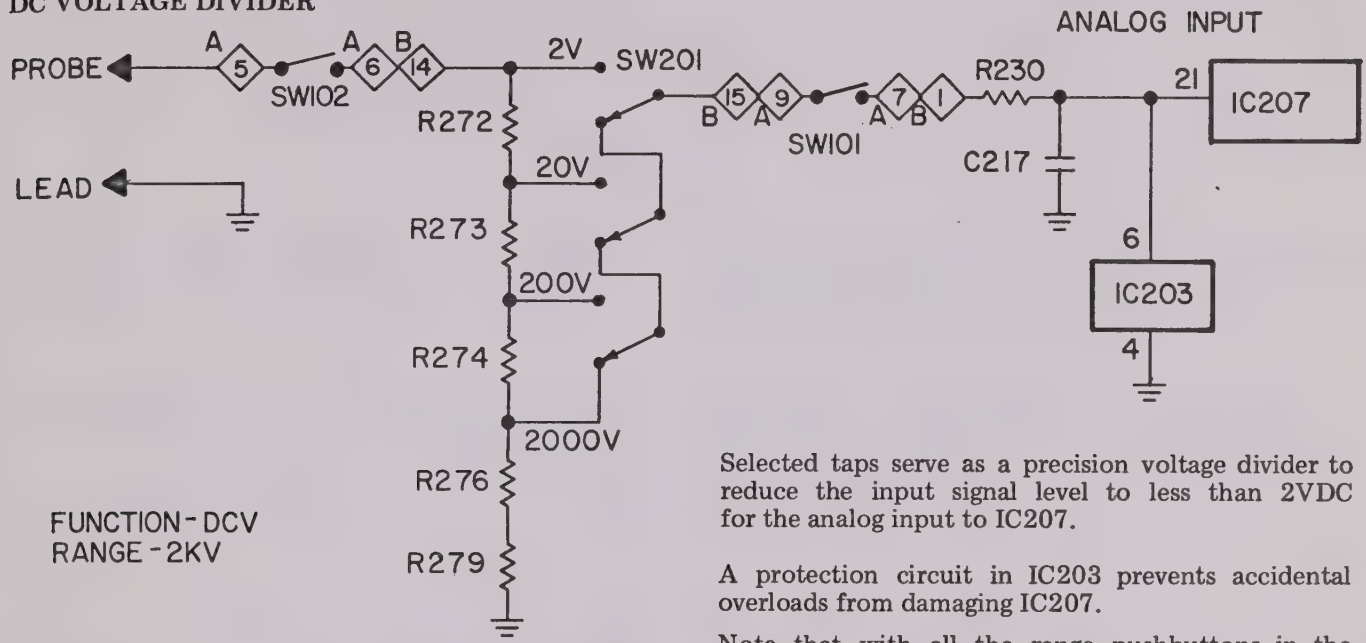
A bridge rectifier circuit (CR202 - 205) and filter networks (R201, C202, R202, C203) feed the regulator ICs with an unregulated positive and negative 15 volts. Circuit ground is referenced to a center tap on the transformer secondary.

Sources of positive and negative 14 volts power the ICs and also serve as the B+ line for some of the transistor circuits. The +14V output is regulated by IC202. The divider formed by R205 and R206 at the output forms a control voltage at the junction which is fed back to IC202 to determine the amplifier gain. The −14V regulator, IC201, and the divider formed by R203 and R204 operate in a like manner. CR206 and C204 protect and filter the sources.

The 14 volt sources are stepped down and zener regulated through CR217 and CR218 to provide the positive and negative 6 volt sources. C216 further filters the output against circuit interaction.

A separate secondary winding and rectifier (CR201) are used for the +6 volt unregulated line that supplies the B+ for the L.E.D. readout drivers.

DC VOLTAGE DIVIDER



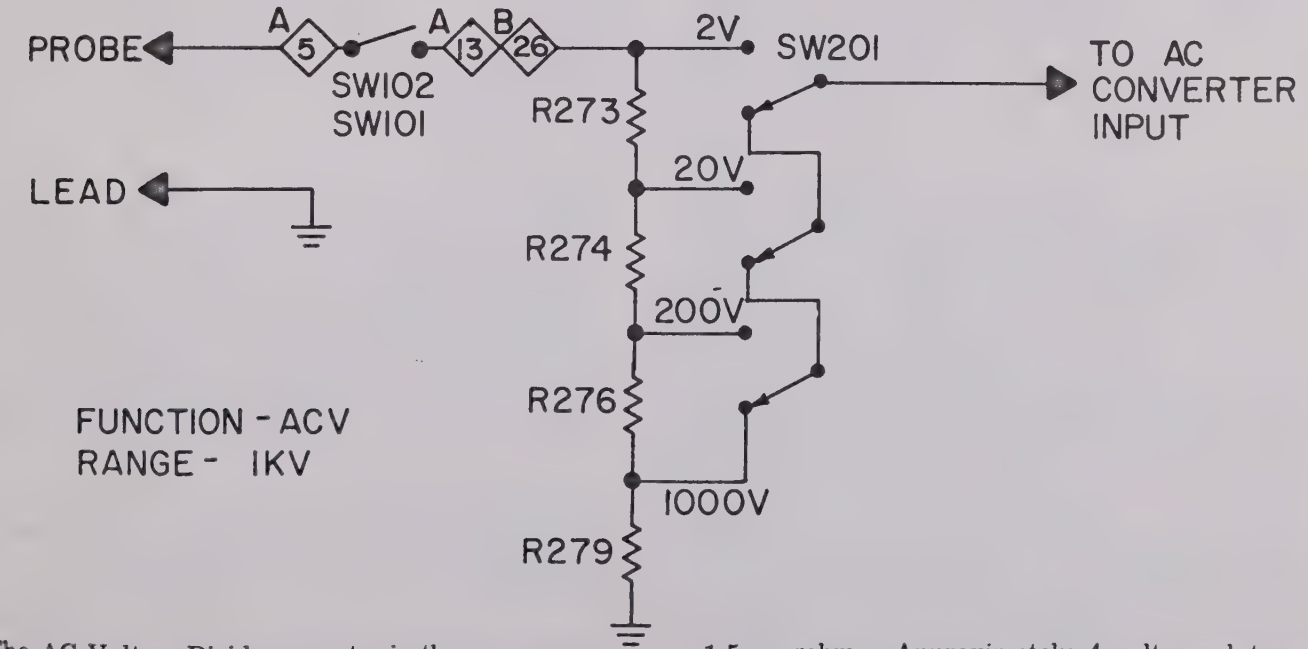
The DC Voltage Divider maintains a constant 15 megohm input impedance to the measured circuit.

Selected taps serve as a precision voltage divider to reduce the input signal level to less than 2VDC for the analog input to IC207.

A protection circuit in IC203 prevents accidental overloads from damaging IC207.

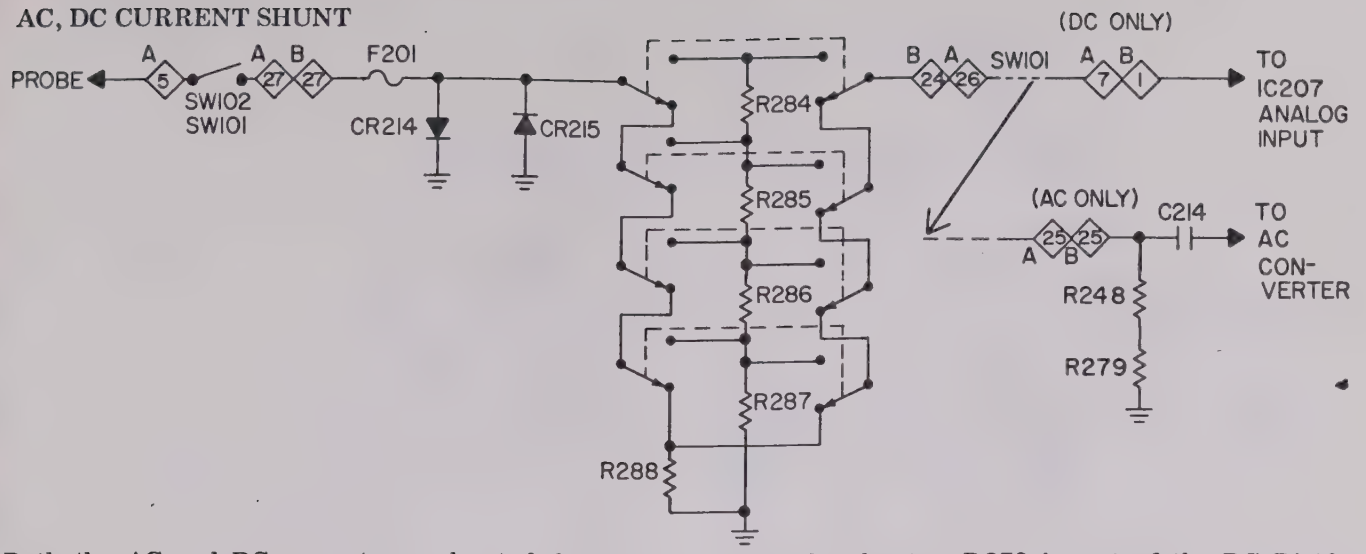
Note that with all the range pushbuttons in the normal out positions the highest voltage range is automatically selected to protect the input circuits.

AC VOLTAGE DIVIDER



The AC Voltage Divider operates in the same manner as the DC Divider, except R272 is not connected in the series. The total AC input impedance is a constant 1.5 megohm. Approximately 4 volts peak-to-peak AC at full scale reading is fed to the input of the AC Converter.

AC, DC CURRENT SHUNT

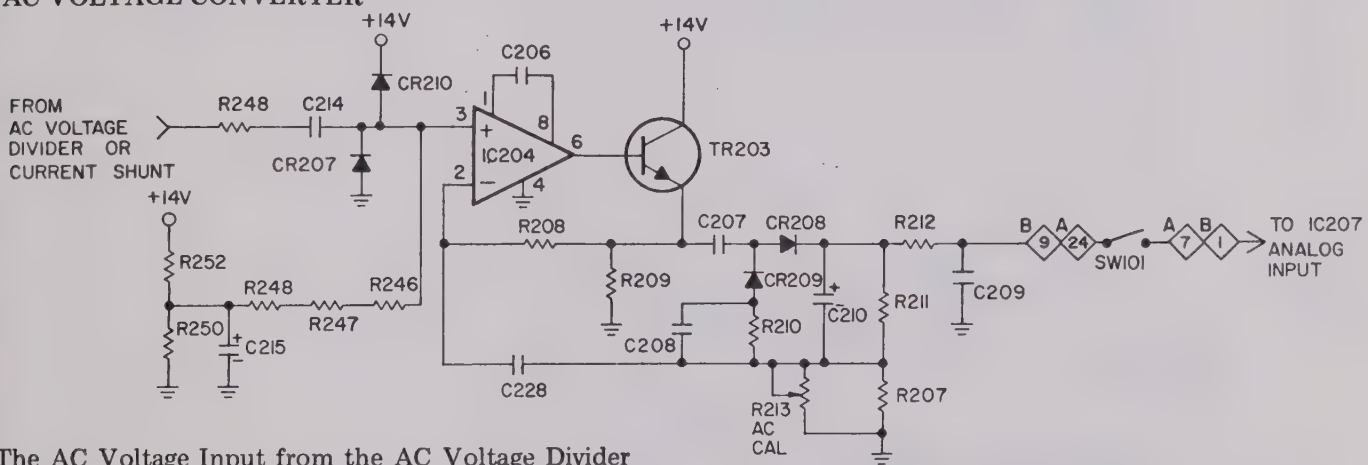


Both the AC and DC currents are shunted through R284 to R288. The voltage drop developed across these shunts is of the proper value for the Analog Input to IC207.

In the AC Current position, R248 is switched in series with R279 to improve the accuracy on the high AC ranges by isolating the DC Voltage Divider from the shunts. R279 is part of the DC Divider and would otherwise be in parallel with the AC shunts. C214 is a DC blocking capacitor.

Diodes CR214 and CR215 are used for voltage overload protection, and fuse F201 will open the circuit if the current exceeds 2 Amps.

AC VOLTAGE CONVERTER



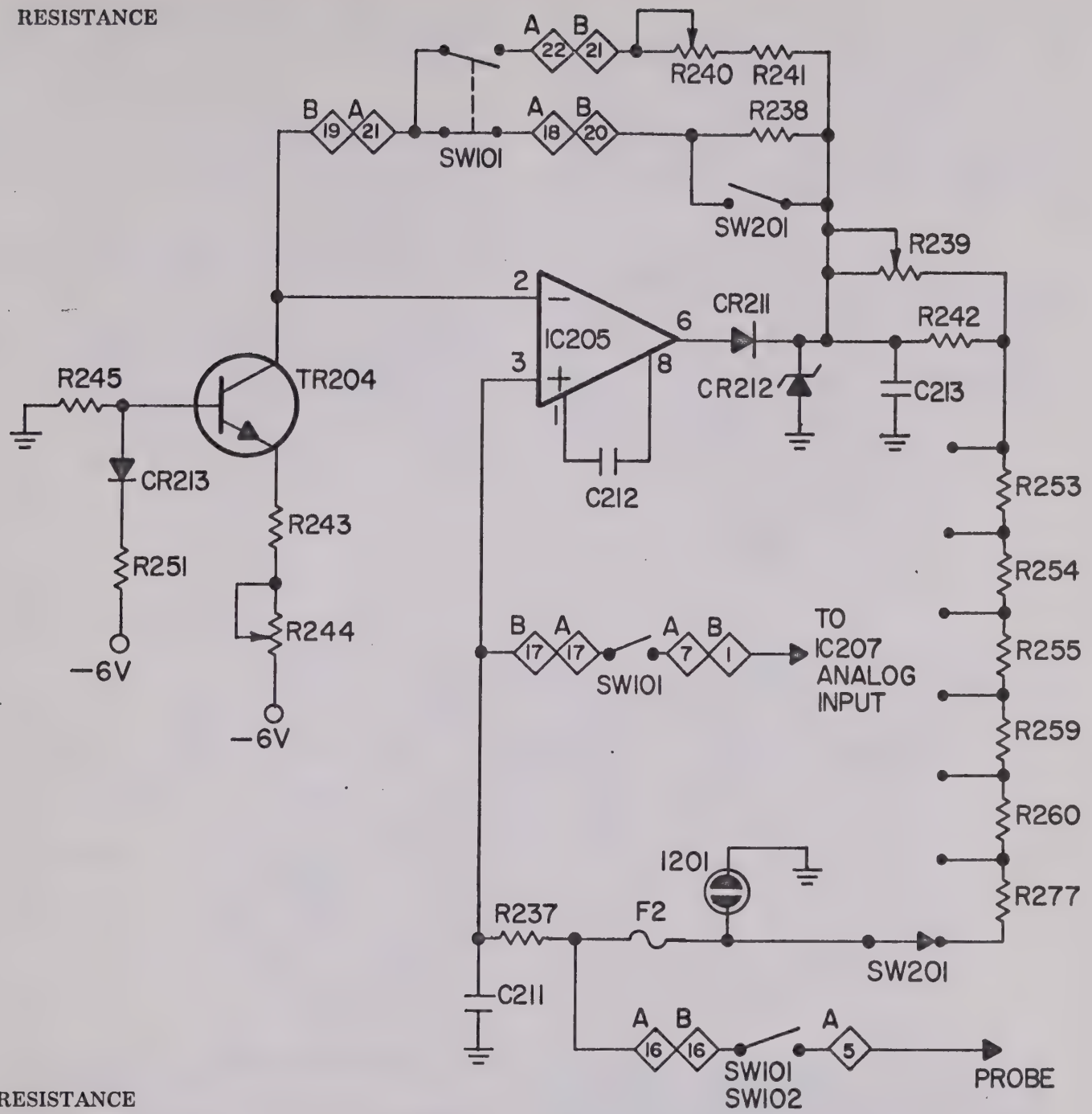
The AC Voltage Input from the AC Voltage Divider or Current Shunt is fed to the AC Voltage Converter to be changed to the DC voltage required by the A/D Converter. The input enters IC204 after passing through a DC blocking network (R248, C214) and the protection circuit (CR210, CR207). IC204 is an op-amp that amplifies the signal to approximately 13V p-p. This level is required to overcome the losses to the output signal due to rectification and averaging of the input AC signal.

The CMOS Op Amp is extremely linear, but does not have adequate drive for the detector circuit. Therefore, TR203 is connected as an emitter follower that provides a constant output impedance to drive the detector circuit.

C207 blocks the DC component, but passes AC to the detector circuit. CR209 shunts the AC negative half cycle to ground through R210 and C208. CR208 passes the positive half cycle which charges C210 to the average value. The output is filtered through R212 and C209 and becomes the Analog Input for the A/D Converter, IC207.

Precision resistors R211 and R207 form an AC voltage divider that determines the AC feedback level to IC204 through C228. This feedback, plus the DC return through R208, determines the Op Amp gain and improves linearity. R213 serves as the AC calibration control by paralleling R207 in the divider.

Since the IC204 negative supply is at ground potential, the divider formed by R252 and R250 between the +14 volt source and ground offsets the (+) input to pin 3 to +7 volts for proper DC balance at the output. High resistance isolation from B+ is maintained by R246, 247, and 248. C215 filters this line.



RESISTANCE

For high power ohms, a constant 10 volt differential between the IC205 input and output (pins 2 and 6) is produced by constant current from the source TR204 flowing through the feedback resistance (either R238 or R240 and R241).

Since the "+" and "—" inputs to IC207 always track each other to maintain the same potential, the constant 10 volt differential is also across the range resistors R242 through R277. The total resistance of the range resistors determines the current level through them and the unknown resistance. A voltage is thus produced across R_X that is proportional to its resistance. This voltage, with respect to ground, is used to produce the digital resistance readout in IC207. It also offsets the IC205 pin 3 input, causing the pin 2 input to track at the same level with respect to ground. This maintains the constant 10 volt input-to - output differential regardless of the unknown resistance value.

In the HI — PWR OHMS function, R238 sets the 10 volt differential. For LO — PWR OHMS, this becomes a 1 volt differential as determined by R241 and R240. The sensitivity of the A/D Converter, IC207, is increased by 10 in LO — OHMS to keep the same digital readout scale. This network is shorted by SW201 if the 20 or 200 ohm ranges are selected

in the HI — PWR Function. This condition produces a "000" output to IC207 regardless of the resistance being measured, to indicate that LO — PWR should be selected for these two ranges.

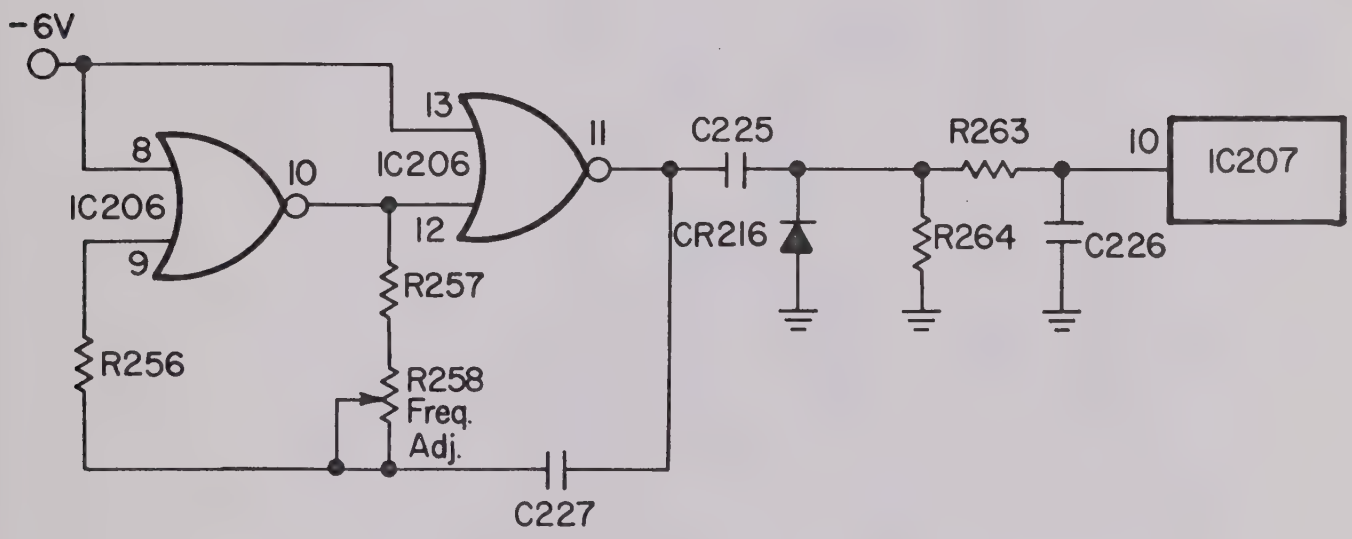
In the constant current source circuit, the TR204 base is kept at a constant potential by R245, CR213, and R251. R243 and R244 determine and calibrate the Ohms scale.

For the op amp IC205 input and output, C211 and C213 filter any AC or noise. C212 prevents oscillation through the feedback path.

Several devices protect the components from damage during accidental overloads. The series range resistors offer protection, particularly in the higher range positions, by limiting the current through the circuit. F2 is a 1/16 Amp fuse that opens when the maximum current level is exceeded. It prevents damage to the range resistors when the lower range positions are used. Voltage transients and overloads are limited to 65 volts by I1, a neon bulb. CR211 and CR212 protect the IC205 output. Zener CR212 will shunt any negative pulse to ground and will limit any positive overload to 15 volts. CR211 further blocks the overload from entering the op amp output. R237 isolates the IC205 and IC207 inputs from the overload.

R244 calibrates the ohms scale by controlling the reference current level. The LO PWR resistance adjustment is made with R240 which changes the gain of the op amp IC205. R239 parallels R242 to calibrate the 20 ohm range. This calibration is necessary when F2, 1/16 Amp fuse, is replaced because of varying fuse resistance.

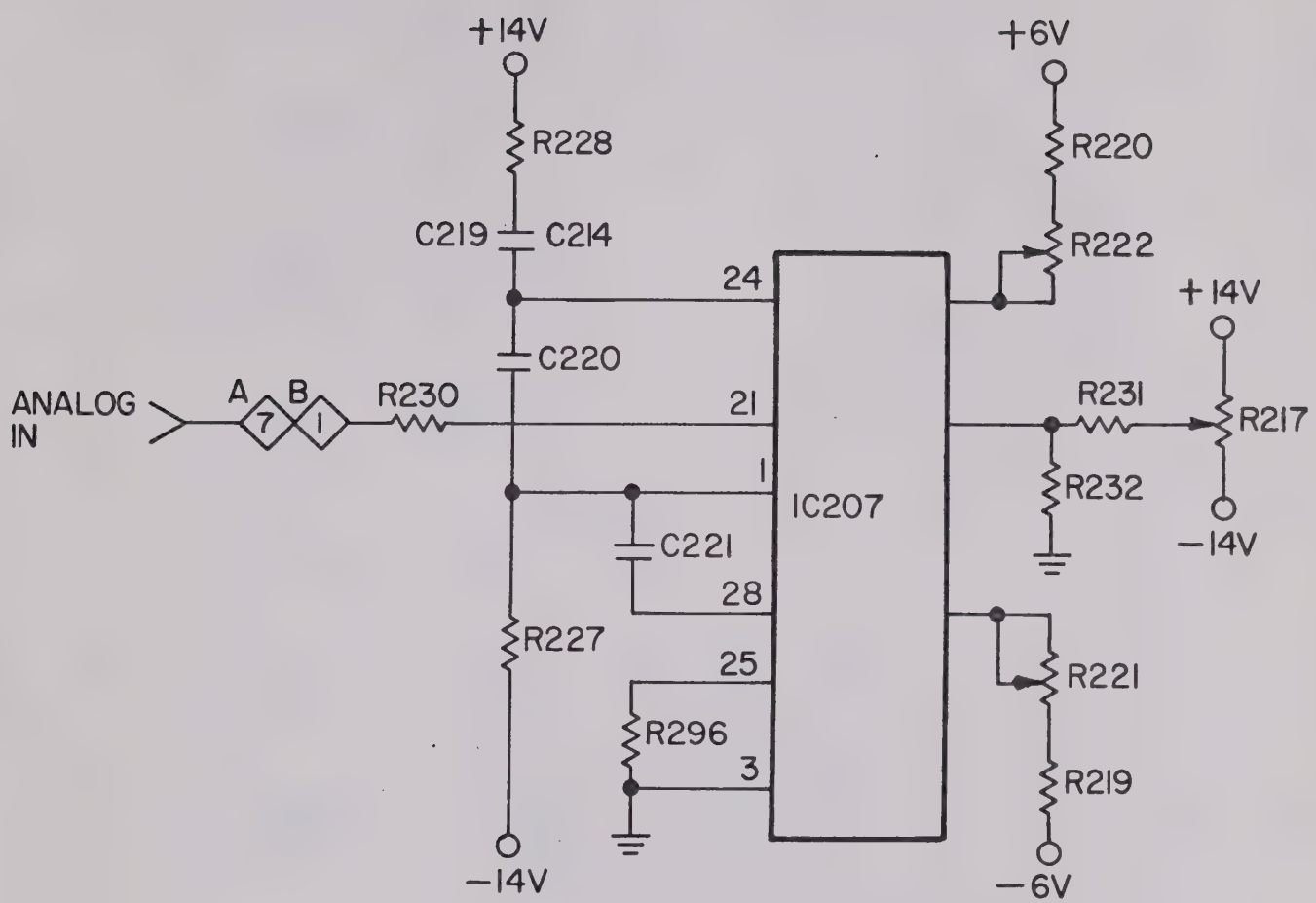
CLOCK



The Clock generates a 160 KHz pulse output to be used by the A/D Converter.

The Clock uses IC206 in a NOR gate flip-flop configuration. The feedback path through C227, R258, and R257 determines the oscillator frequency, with R258 calibrating the frequency. R256 resets the first gate at the end of each cycle.

The AC output from the gates passes through the DC blocking capacitor, C225, and is clipped by CR216. R263 and C226 form an integrator which rounds the leading edge of the pulse so that IC207 will accept it. R264 restores the DC path.



RAMP

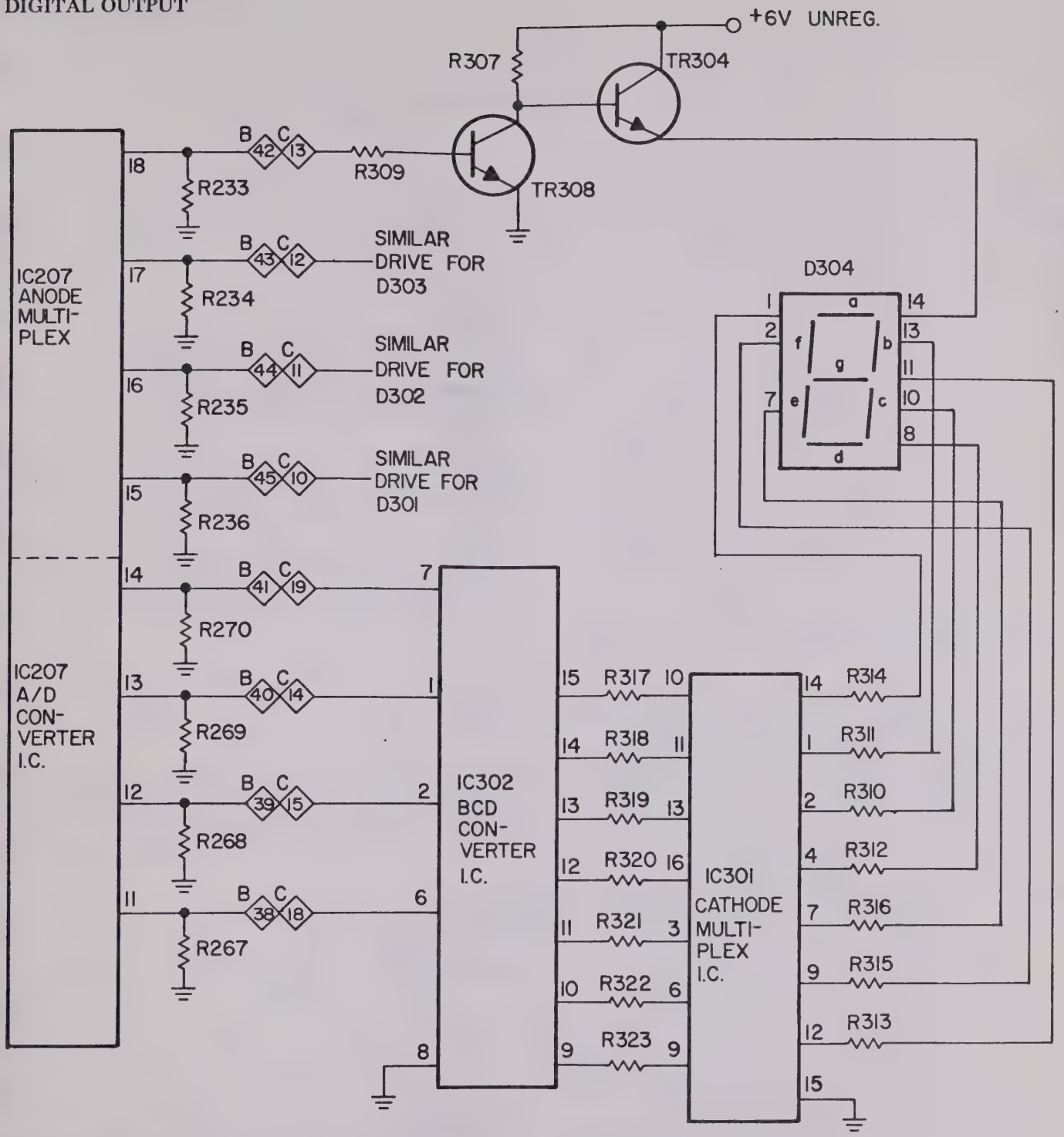
The key operation performed by the Analog to Digital Converter IC207 consists of charging the integrating capacitor C221 through R296 to a value proportional to the Analog Input voltage. This ramp is produced during the first count period.

This integrated input voltage on C221 is then discharged to zero at a constant rate through R222 and R220, if positive, or R221 and R219, if negative. The conversion to coded digital output is made when the voltage reaches zero on C221.

The third, or zeroing count period is used to establish the zero reference for the charge - discharge cycle. Zero shift and errors are eliminated with this comparison each sample period.

Extremely high stability and accuracy is achieved by making the read, count, and zero operations within a single sample period (300 msec.).

The "000" readout is determined by the R217 control, and the divider R231 and R232. C220 improves stability during the auto zero interval. C219 and R228 stabilize the feedback circuit to prevent oscillation on the overrange display. R227 improves the ramp linearity. Calibration is made by R222 on positive Analog Input voltages, and by R221 on negative inputs.



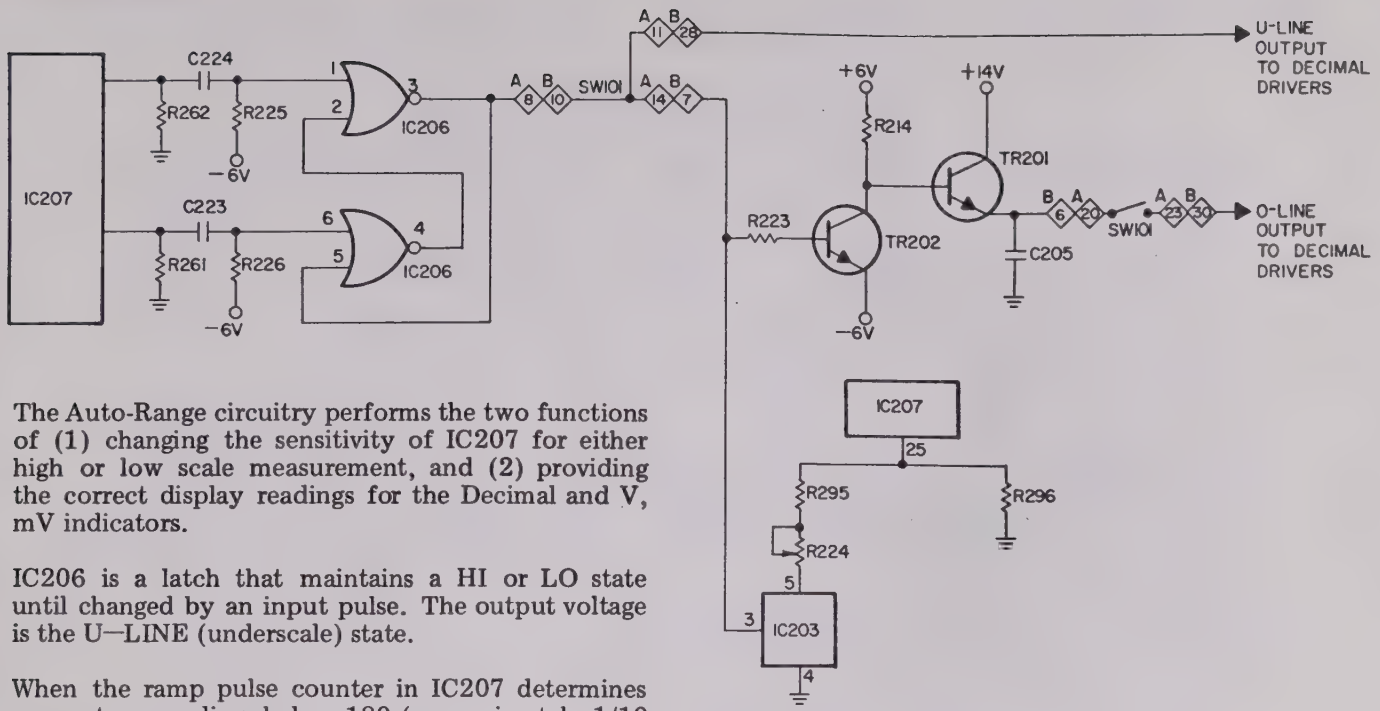
DIGITAL OUTPUT

When the integrating capacitor in the ramp circuit is discharged to zero during the count period, the number of clock pulses at that instant is latched, converted, and transfered to the Binary Coded Decimal (BCD) circuits in IC207.

These four digits are stored and then displayed in sequence at a 5KHz rate. The BCD output selects which cathode elements are to be lit while the Anode Multiplex output individually strobes the display digits. Only the display segments that have both the cathode and anode selected will complete the current path and illuminate.

IC302 accepts the BCD output and converts it to seven segment information for the display drivers in IC301.

AUTO-RANGE



The Auto-Range circuitry performs the two functions of (1) changing the sensitivity of IC207 for either high or low scale measurement, and (2) providing the correct display readings for the Decimal and V, mV indicators.

IC206 is a latch that maintains a HI or LO state until changed by an input pulse. The output voltage is the U—LINE (underscale) state.

When the ramp pulse counter in IC207 determines a count, or reading, below 180 (approximately 1/10 of a full scale), it produces a positive pulse at pin 4. IC206 then latches the U—LINE at pin 3 to a HI state.

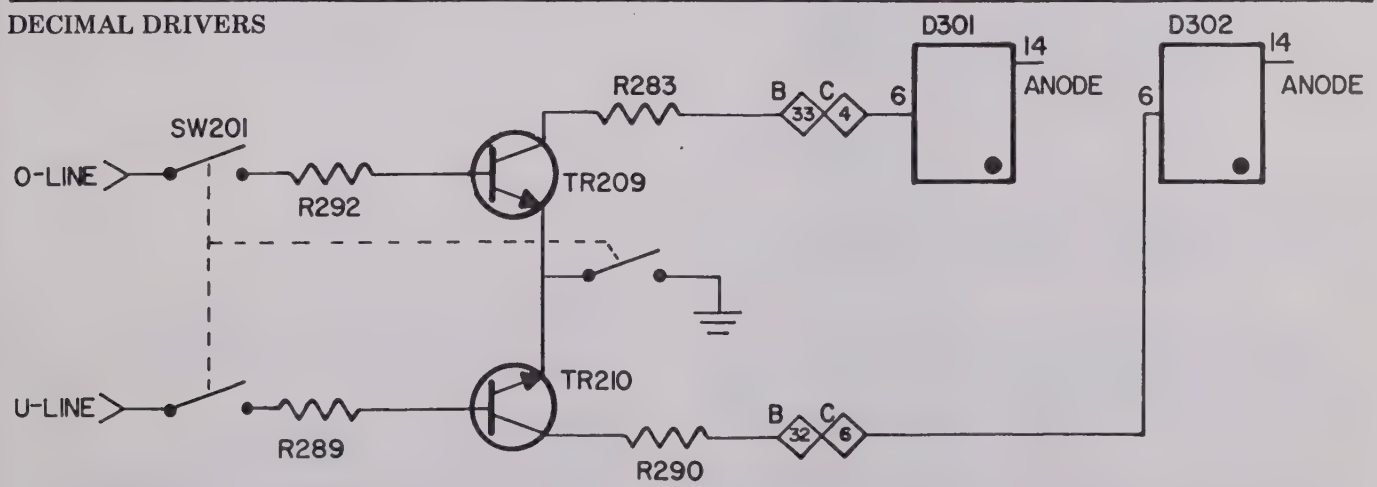
If the count goes above 1999, a pulse is produced at pin 6, causing the U—LINE to be reset to the LO state by IC206.

Transistor TR202 inverts the U—LINE state to produce the O—LINE (overscale) state. The U—LINE and O—LINE are always in opposite states.

TR201 serves as an emitter follower on the O—LINE to the "V" and "mV" indicator driver transistors.

R296 determines the gain of IC207 by providing a 1 megohm path to ground. When the U—LINE goes to the HI state, IC203 completes the ground return for R295 and R294. These now parallel R296 for a total resistance of 100K ohms, increasing the IC207 gain ten times.

DECIMAL DRIVERS



The proper decimal display is controlled by the Function and Range switches, and the O—LINE and U—LINE states. A simplified example of the three decimal positions is shown.

The correct pair of driver transistors is selected by grounding both emitters with the range switch. The O—LINE and U—LINEs will then control which transistor will be driven ON with the HI state on the

base. This HI state saturation will complete the ground return for display decimal, lighting the proper indicator for either the Auto-Range high or low scale.

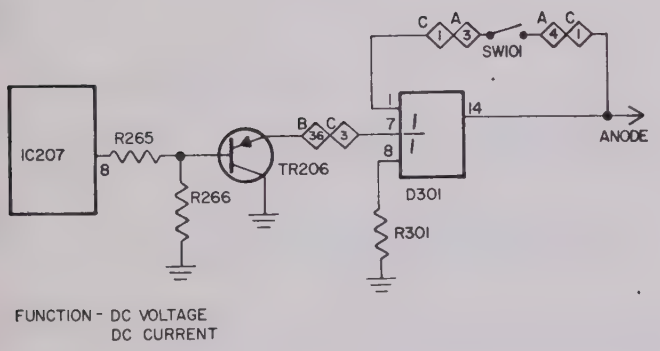
The chart shows which transistor is driven, and the base connection for each range. The range switch also grounds the emitter of the selected transistor.

DRIVER TRANSISTOR AND O AND U LINE STATES
FOR AUTO – RANGE FUNCTIONS

DC, AC RANGE	2V	20V	200V	2000V
O–LINE HI READOUT	1.999	19.99	199.9	1999
TR	TR208	TR210	TR212	NO DECIMAL
BASE	0	0	0	
U–LINE HI READOUT	199.9	1.999	19.99	199.9
TR	TR213	TR209	TR211	TR213
BASE	U	U	U	U

NOTE: O–LINE and U–LINE states for other ranges and functions are determined by the FUNCTION and range switch positions.

POLARITY INDICATOR

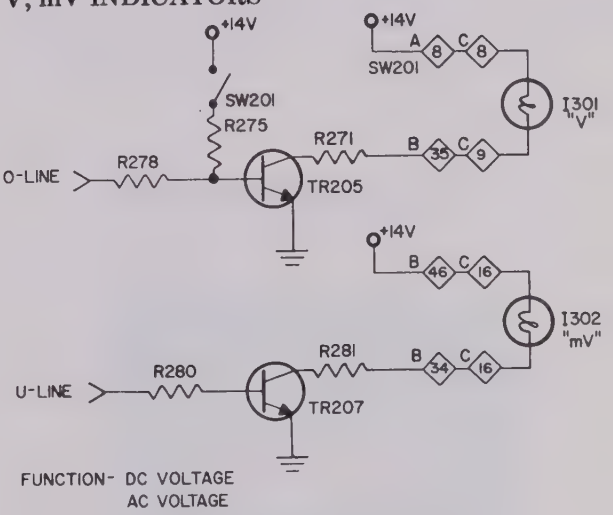


The Polarity Indicator circuit lights the "+" L.E.D. indicator in the DC Voltage and Current functions, according to the polarity of the input signal.

In the DC functions, SW101 connects the polarity indicator anode at pin 1 of D301 to the display anode. The ground return for the "–" display segment is made through R301, so this indicator is ON continuously.

When the measured ramp voltage in IC207 is positive going, a LO output occurs at pin 8, turning TR206 ON. This completes the ground for the "+" indicator and illuminates the display.

V, mV INDICATORS



The Volt and milliVolt lights respond to the O– and U–LINE outputs on the 2V AC or DC Ranges to indicate how the upper or lower readout is to be read.

For all the voltage ranges except 2V, the base of TR205 is tied to the +14V source through R275. TR205 saturates, completing the ground return for the "V" lamp I301 and lighting it.

When 2V is selected, the Range switch connects the bases of TR205 and TR207 to the O– and U–LINEs, respectively. Again, these lines are always in opposite states, so either indicator lamp I301 or I302 will light according to the line having the HI state. Both lights are switched off in all functions other than DC or AC Voltage.

MAINTENANCE AND SERVICE

INTRODUCTION

This Maintenance and Service Section will help you to maintain the DVM38 within the published specifications and assure years of useful application.

The schematic, parts location diagrams, and parts list are included as a separate sheet to this manual. Warranty information is printed on the back of the Quality Assurance tag attached to the instrument. Factory Service information is located inside the back cover of this manual.

A portion of the final testing results are included with your instrument on the Proof of Performance Sheet. This sheet shows the actual measurements your DVM38 made during the final factory tests.

ACCESS/DISASSEMBLY

To gain access to the interior of the DVM38, use this procedure:

1. With the OFF Function pushbutton pressed, disconnect the AC power cord.
2. Remove the four screws at each side of the black case top, and the four screws holding the case bottom.
3. Slide the top and bottom case covers from the instrument. All internal fuses are now exposed.
4. From the bottom of the Range board, unsolder the tabs holding the metal shield. Remove the shield. All calibration controls are now exposed.
5. For reassembly, simply reverse the steps above.

CLEANING

Clean the front panel and case with denatured alcohol or a mild solution of detergent and water. Use a soft cloth when cleaning the display lens to prevent scratching.

FUSE REPLACEMENT

WARNING: Use the proper type fuse for replacement only. Damage may occur to the instrument if the improper fuse is used. Use only "fast blow" types. Warranty is invalid if an instrument shows signs of improper fuse use.

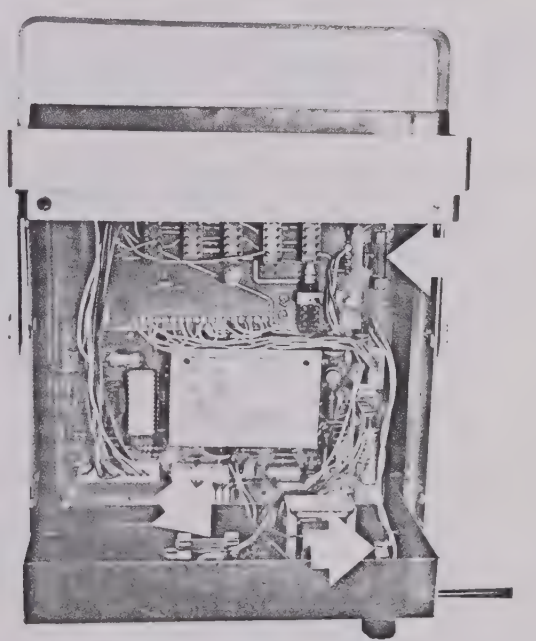
LINE POWER	AGC 2/10A
OHMS	AGC 1/16A
CURRENT	AGC 2A

Disconnect the AC power cord from the AC outlet before changing the fuses.

The Line Power and Current fuses are located inside the DVM38 case. Follow the instructions under ACCESS/DISASSEMBLY to remove the top cover and expose the fuse holders.

The Line Power fuse, F1, holder is located on the inside back panel. Use replacement type AGC 2/10 Amp (fast blow only).

The Current fuse, F201, is mounted on the edge of the Range board near the terminal inputs. Use replacement type AGC 2 Amp (fast blow only).



The Ohms Protection fuse, F2, is located in the fuse holder on the DVM38 Rear Panel. When replacement is required, install an AGC 1/16 Amp fuse in the holder (fast blow only).

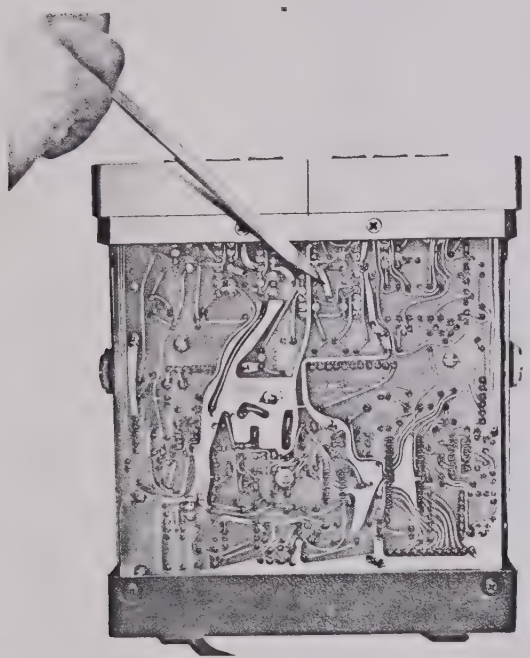
NOTE: The operation of the 20 ohm range should be checked for the typical "zero" indication by shorting the leads on this range and observing the readout. This reading should be approximately .30 to .34 ohms (see RESISTANCE MEASUREMENT).

The 20 ohm range is extremely sensitive and different ohms fuse resistance may produce different "zero" readings. If the shorted resistance reading is beyond this range, it will be necessary to recalibrate R239, 20 ohm Range Cal, as follows:

1. Remove the bottom cover, as instructed in ACCESS/DISASSEMBLY to expose R239 near the input terminals.

2. Short the test probe and lead. Note the reading obtained.

3. Connect the probe across a precision 10 ohm resistor (± .5%). Touch the probe to the junction of R285 and R286 (as shown) if no other precision standard is available.



4. Adjust the R239 control for a reading equaling 10.00 ohms plus the shorted lead resistance.

5. Reassemble the DVM38.

PERFORMANCE TEST

The performance test should be made at regular intervals to determine if the general operation of the DVM38 is within accuracy specifications. The complete calibration procedure should be performed if the performance limits are not met.

ENVIRONMENTAL CONDITIONS:

Temperature 22° — 25°C (72° — 77°F)
Humidity 50 - 70%

ZERO TEST

1. With power applied, select the DC Voltage, 2V Range pushbuttons.

2. Short the Probe and test lead together. The readout should be 000 ± 1 digit.

NORMAL MODE REJECTION TEST

1. With the power applied, select the DC Voltage, 2V Range pushbuttons.

2. Apply AC line voltage to the probe and test lead. The readout should be 000 ± 2 digits.

ACCURACY TESTS

To make the accuracy comparison tests, follow the Calibration Chart, noting the Readout and Limits for the given inputs. Disregard the Adjustments column. The accuracy checks compare the instrument performance with the published specifications.

CALIBRATION PROCEDURE

The calibration procedure should be performed at regular intervals (six months recommended) to restore DVM38 performance to the original accuracy specifications.

The test standards required for calibration and performance are listed below.

EQUIPMENT	SPECIFICATIONS
Frequency Counter	To measure 160 KHz ± 50Hz
DC Voltage Source	100mV to 1000V ± 0.02%
DC Current Source	100uA to 1A ± 0.1%
AC Voltage Source	100mV to 1000V ± 0.1%
AC Current Source	100uA to 1A ± 0.3%
Resistors	19, 190, 1.9K, 19K, 190K, 1.9M, 19M ohm ± 0.1%

The DVM38 should be calibrated under the following environmental conditions:

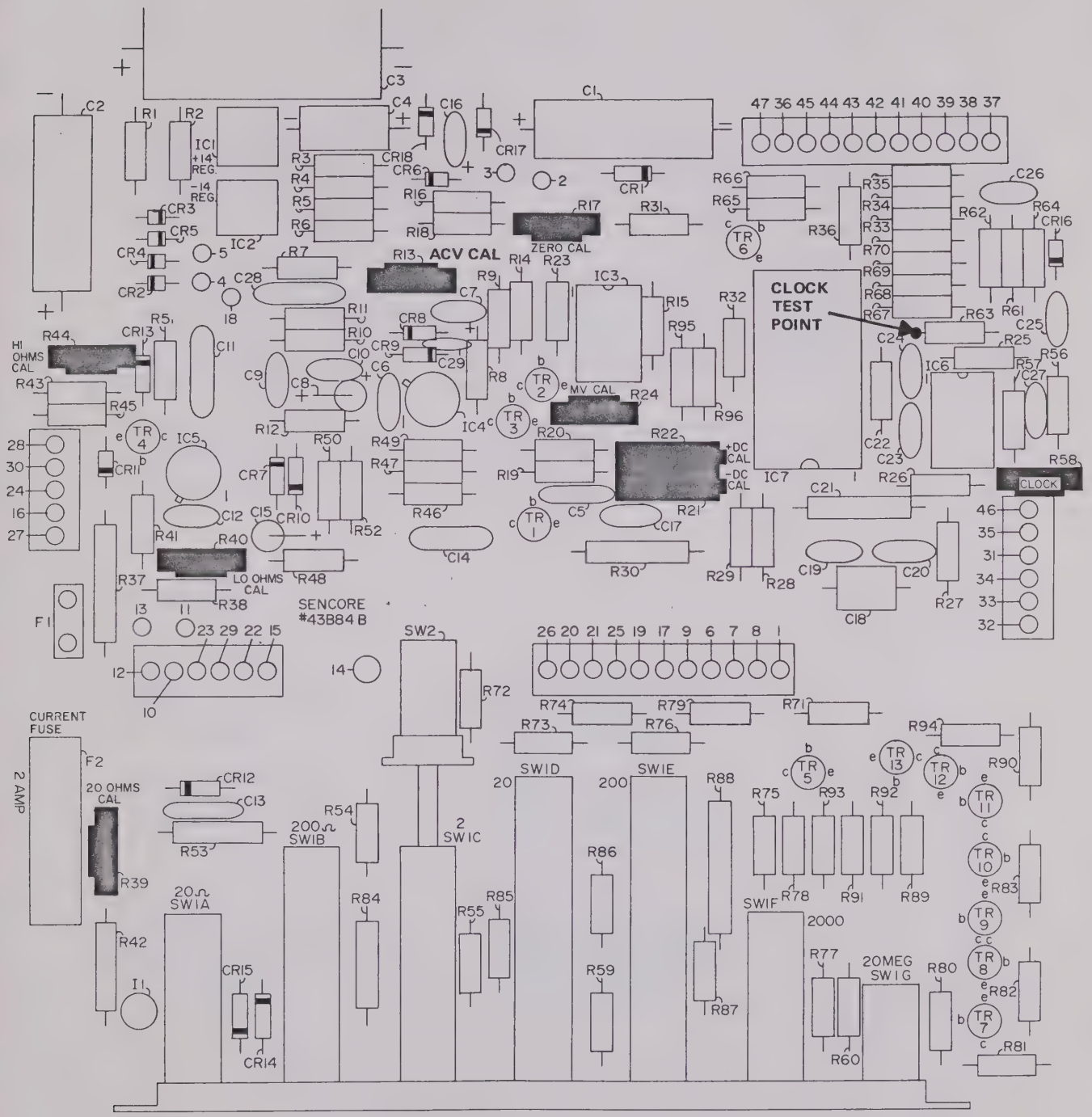
Temperature 22° — 25°C (72° — 77°F)
Humidity 50 — 70%

Follow the DVM38 Calibration Procedure Chart. Apply the inputs listed and check for the Readout and Limits indicated. A simplified Calibration Location diagram is included for quick reference to the DVM38 board.

DVM38
CALIBRATION PROCEDURE

FUNCTION	RANGE	INPUT	ADJUSTMENT	READOUT
DC Volts	2V	———	R258 Clock Adj	160,000Hz (±50Hz)
DC Volts	2V	Leads shorted	R217 Zero Readout	.000 (± 0)
DC Volts	2V	+1.900V DC	R222 + DC Cal	+1.900 (±.001)
DC Volts	2V	—1.900V DC	R221 —DC Cal	—1.900 (± .001)
DC Volts	2V	± 190.0mV DC	R224 Lo DC Cal	± 190.0 (± .3)
DC Volts	20V	19.00V DC	———	19.00 (± .02)
DC Volts	200V	190.0V DC	———	190.0 (± .2)
DC Volts	1000V	1000V DC	———	1000 (± 2)
AC Volts	2V	1.900V AC	R213 AC Volt Cal	1.900 (± .004)
AC Volts	20V	19.00V AC	———	19.00 (± .04)
AC Volts	200V	190.0V AC	———	190.0 (± .4)
AC Volts	1000V	1000V AC	———	1000 (± 4)
DC Current	200uA	190.0uA	———	190.0 (± .5)
DC Current	2mA	1.900mA	———	1.900 (± .005)
DC Current	20mA	19.00mA	———	19.00 (± .05)
DC Current	200mA	190.0mA	———	190.0 (± .5)
DC Current	2000mA	1900mA	———	1900 (± 5)
AC Current	200uA	190.0uA	———	190.0 (± .5)
AC Current	2mA	1.900mA	———	1.900 (± .005)
AC Current	20mA	19.00mA	———	19.00 (± .05)
AC Current	200mA	190.0mA	———	190.0 (± .5)
AC Current	2000mA	1900mA	———	1900 (± 5)
HI PWR Ohms	2K ohm	1900 ohm	R224 Hi Pwr Cal	1900 (± 2)
LO PWR Ohms	2K ohm	1900 ohm	R240 Lo Pwr Cal	1900 (± 2)
LO PWR Ohms	20 ohm	Leads Shorted	———	Note Reading
LO PWR Ohms	20 ohm	19.00 ohm	R239 20 ohm Cal	19.00 + shorted lead reading (± .02)
HI PWR Ohms	200 ohm	190.0 ohm	———	190.0 (± .5)
HI PWR Ohms	20K ohm	19.00K ohm	———	19.00 (± .05)
HI PWR Ohms	200K ohm	190.0 K ohm	———	190.0 (± .5)
HI PWR Ohms	200K ohm	19.00M ohm	———	19.00 (± .05)

CALIBRATION CONTROL LOCATION DIAGRAM



SERVICE AND WARRANTY

You have just purchased one of the finest Digital Multimeters on the market today. The Sencore DVM38 has been inspected and tested twice at the factory and has passed a rugged use test by our Quality Assurance Department to insure the best quality instrument to you. If something should happen, the DVM38 is covered by the exclusive 100% Made Right Lifetime Guarantee as explained on the warranty policy enclosed with your instrument.

Sencore has six Regional Offices to serve you. Instruments to be serviced should be returned to the nearest Regional Office by UPS if possible. Parcel Post should only be used as a last resort. Instruments should be packed with the original packing materials or equivalent, and double boxed to insure safe arrival at the Regional Office. The display carton is not an acceptable shipping container. When returning an instrument for service, be sure to state the nature of the problem to insure faster service.

If you wish to repair your own DVM38, we have included a schematic and parts list. Any of these parts may be ordered directly from the Regional Office nearest you.

We reserve the right to examine defective components before an in warranty replacement is issued.

SENCORE REGIONAL OFFICES:

Sencore East Central
4105 Duke Street
Alexandria, VA 22304
(703) 751-3556

Sencore Central
2711 B Curtiss Street
Downers Grove, IL 60515
(312) 852-6800

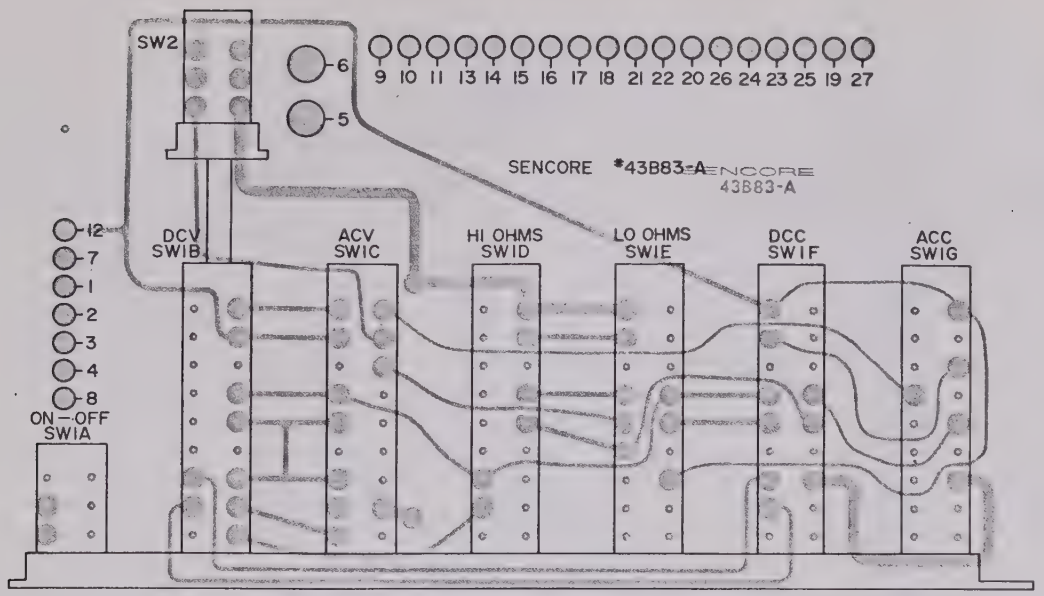
Sencore Western Coast
833 Mahler Road
Burlingame, CA 94010
(415) 697-5854

Sencore West
3200 Sencore Drive
Sioux Falls, SD 57107
(605) 339-0100

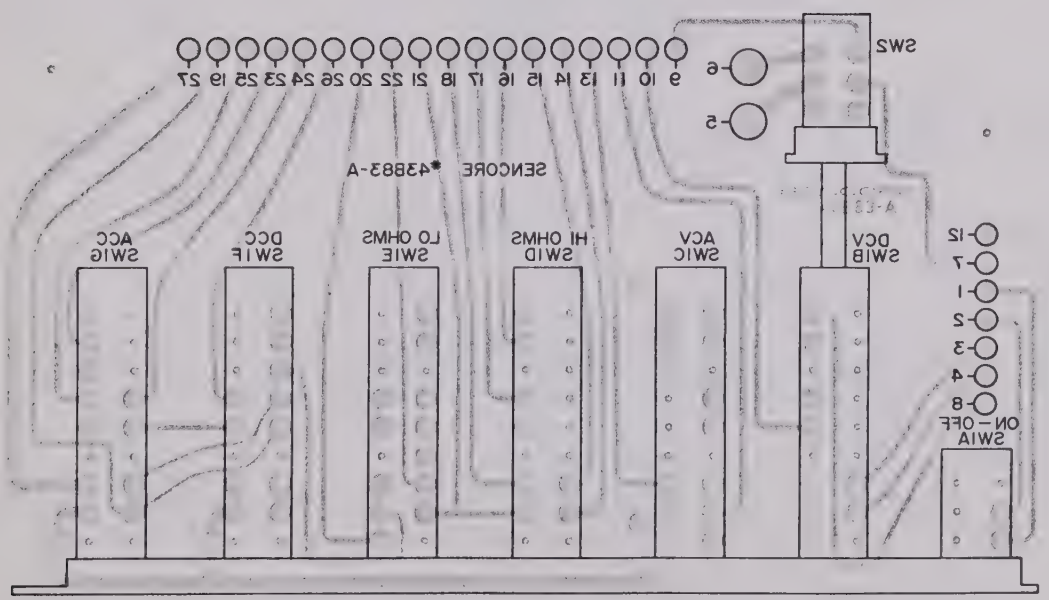
Sencore Southeastern
2459 Roosevelt Hwy Suite B-3
College Park, GA 30337
(404) 768-0606

Sencore Northeastern
1237 Central Avenue
Albany, NY 12205
(518) 459-6040

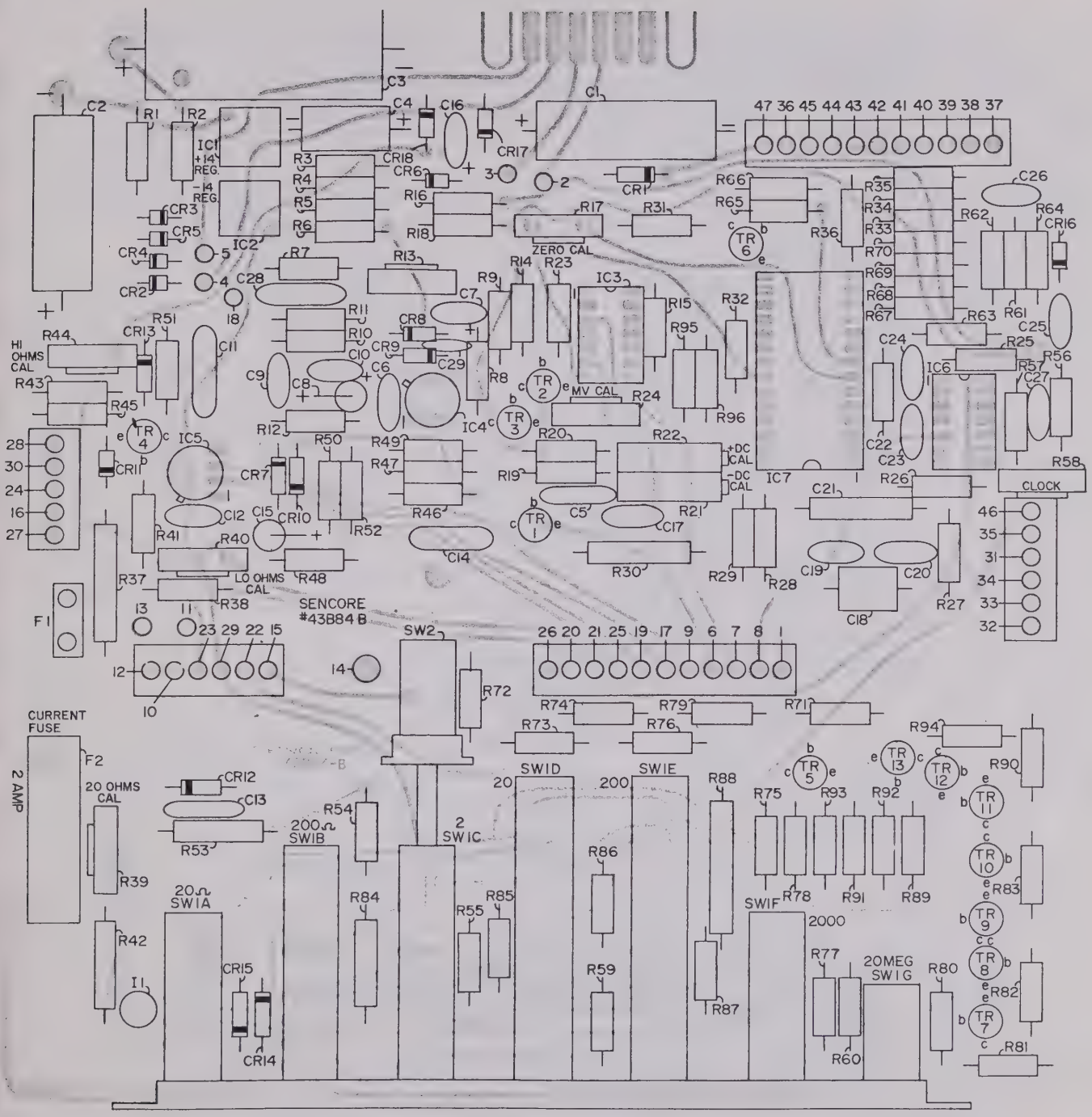
DVM38 BOARD LAYOUT DIAGRAMS



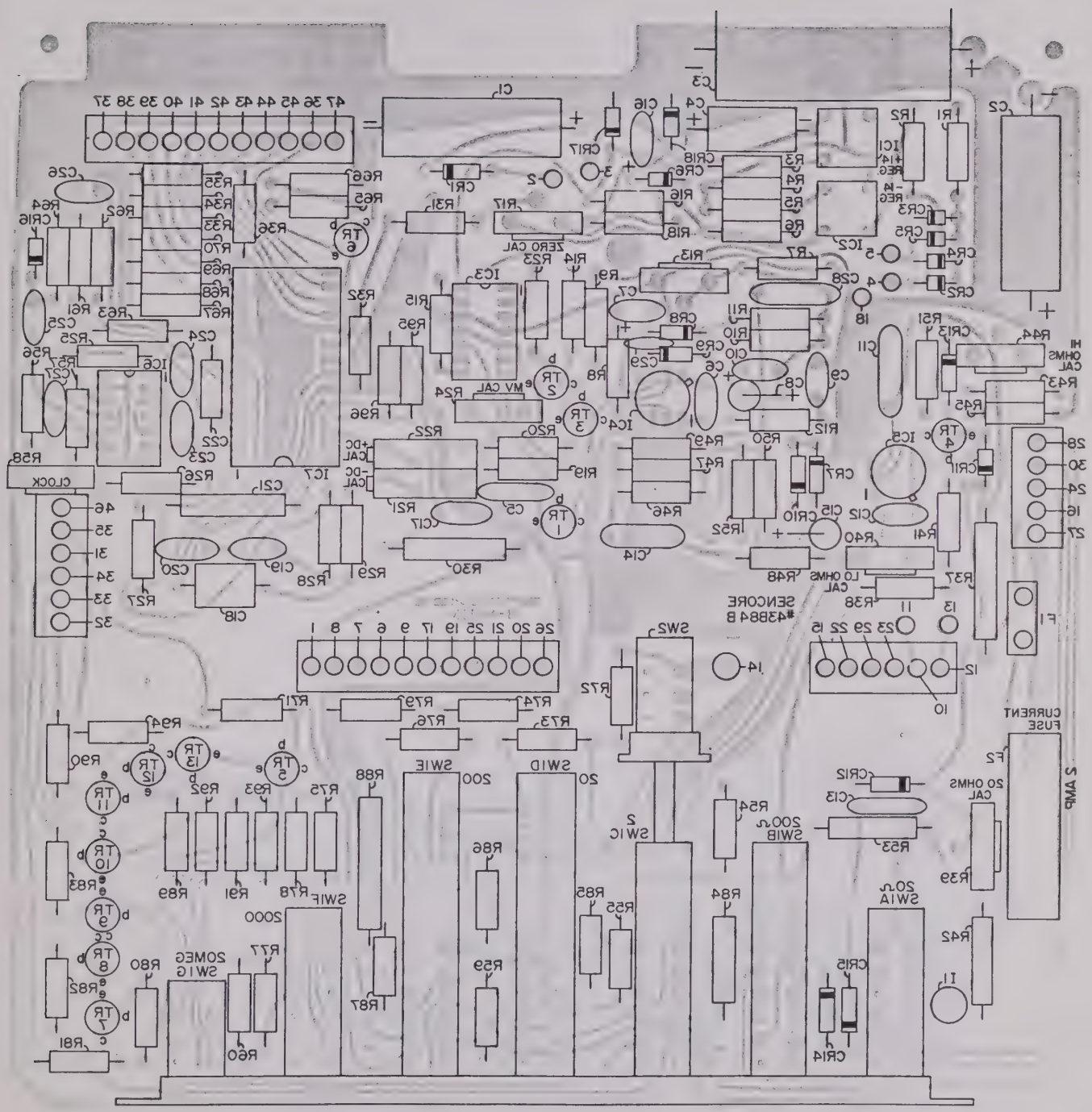
Component Side View



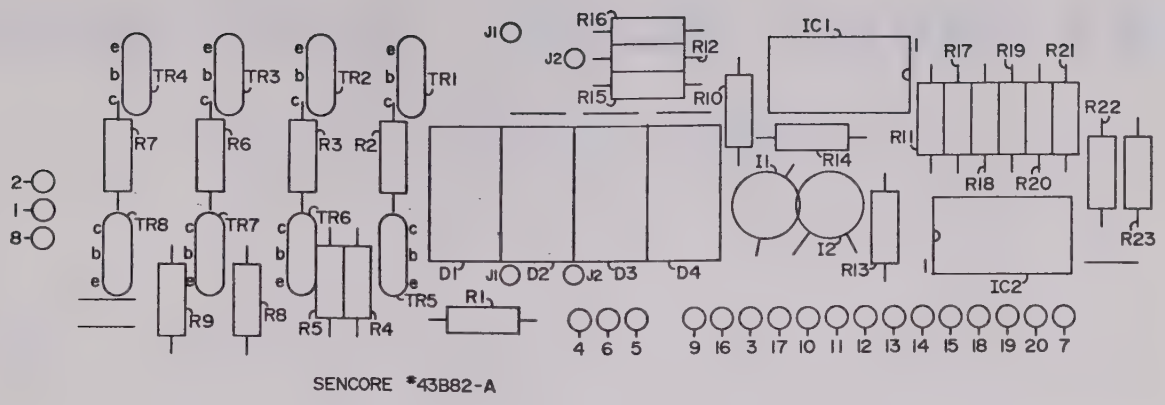
Foil Side View
FUNCTION BOARD



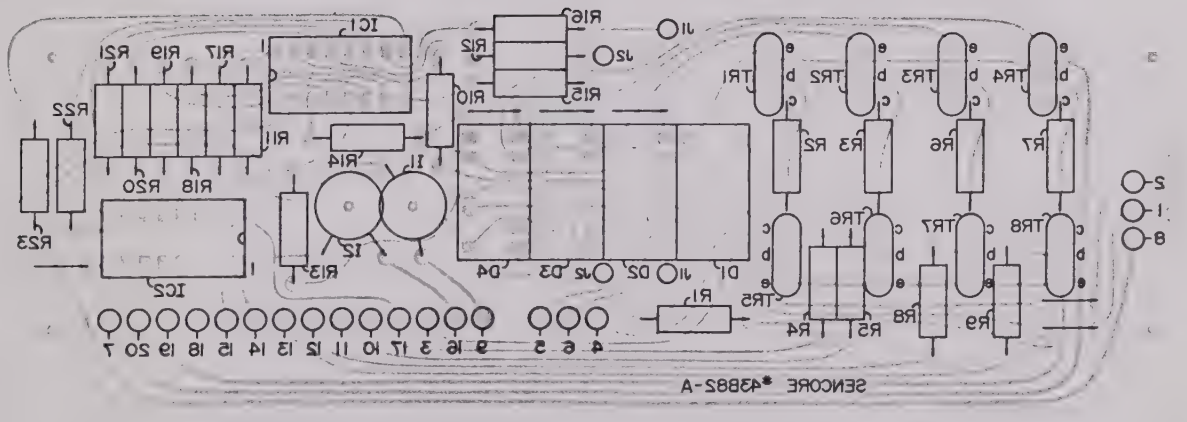
RANGE BOARD
Top View



RANGE BOARD
Bottom View



Component Side View



Foil Side View
DISPLAY BOARD

Form 1201

DVM38

DIGITAL MULTIMETER

SCHEMATIC DIAGRAM & PARTS LIST

BACKED BY SENCORE'S 100% MADE RIGHT LIFETIME GUARANTEE

SENCORE

THE ALL AMERICAN LINE OF HIGH QUALITY TEST EQUIPMENT

DVM38 PARTS LIST

SCHEMATIC REFERENCE	PART NO.	DESCRIPTION	PRICE
FUNCTION BOARD			
SW101	25A223	Switch	12.00
SW102	25A225	Switch	1.50
RANGE BOARD			
IC201	69G16	IC, Neg Volt Reg, uA79MG	3.75
IC202	69G15	IC, Pos Volt Reg, uA78MG	3.50
IC203	69G12	IC, Array, CMOS, 4007	1.25
IC204, 205	69G21	IC, Op Amp, CA3130	3.00
IC206	69G7	IC, Quad NOR Gate, 4001	.75
IC207	69G17	IC, A-D Converter, MN2301	34.00
TR201-205 207-213	19A33	Transistor, NPN, 2N3904	.50
TR206	19A34	Transistor, PNP, 2N3906	.50
CR201, 202, 204, 214, 215	16S10	Diode, 1N4004, 1A	.50
CR203, 205, 208, 209, 211, 213, 216	50C5-2	Diode, 1N4148	.25
CR206, 212	50C4-11	Diode, Zener, 15V, 1N4744	.50
CR207, 210	50C5-1	Diode, 1N456	.25
CR217, 218	50C12-1	Diode, Zener, 6.3V, 1N823	1.50
R213	15C7-13	Control, 100K	.75
R217	15C7-8	Control, 1.2M	.75
R221, 222	15A19-1	Control, 500K, Multiturn	3.75
R224	15C7-10	Control, 1.7K	.75
R239, 244	15C7-14	Control, 5K	.75
R240	15C7-15	Control, 200	.75
R258	15C7-31	Control, 2.5K	.50
SW201	25A225	Switch	1.50
SW202	25A224	Switch	9.75
I201	20G1	Bulb, Neon, NE2	.25
F201	44G12	Fuse, 2A, 3AG	.25
Resistors			
R207	14C30-5003A	5K, 2%, ½W	.75
R211	14C28-1004A	10K, .5%, ½W	.50
R219, 220	14C29-2856A	2.85Meg, 1%, ½W	.75
R230, 237	14C11-105	1Meg, 10%, 2W	.25
R238	14C28-8004A	80K, .5%, ½W	.50
R241	14C28-7903A	7.9K, .5%, ½W	.50
R242	14C32-1002A	100, 1%, 1W	.75
R243	14C29-2004A	20K, 1%, ½W	.75
R245, 251	14C29-1005A	100K, 1%, ½W	.75
R253, 284	14C33-9002A	900, .25%, 1W	.75
R254	14C27-9003A	9K, .25%, ½W	.75
R255	14C27-9004A	90K, .25%, ½W	.75
R257	14C30-1104A	11K, 2%, ½W	.75
R259	14C27-9005A	900K, .25%, ½W	1.00
R260	14C27-9006A	9Meg, .25%, ½W	1.25
R272	14C25-1357A	13.5Meg, .1%, 1W	2.75
R273	14C25-1356A	1.35Meg, .1%, 1W	2.00
R274	14C26-1355A	135K, .1%, ½W	1.25
R276	14C26-1354A	13.5K, .1%, ½W	1.25
R277	14C27-9007A	90Meg, .25%, ½W	2.75
R279	14C26-1503A	1.5K, .1%, ½W	1.25
R285	14C27-9001A	90, .25%, ½W	1.00
R286	14C27-9000A	9, .25%, ½W	1.00

SCHEMATIC REFERENCE	PART NO.	DESCRIPTION	PRICE
R287	14C27-1000A	1.0, .25%, ½W	1.00
R288	42E11	Resistance Wire, 4¼"	.75
R295	14C27-1105A	110K, .25%, ½W	1.25
R296	14C27-1006A	1Meg, .25%, ½W	1.00
Capacitors			
C201, 202	24G252	200mF, 50V, Lytic	1.00
C203	24G272	1000mF, 25V, Lytic	1.75
C204	24G271	50mF, 35V, Lytic	.50
C205	24G31	.03mF, 600V, Disc	.25
C206, 220 223, 224	24G172	100pF, 500V, Disc	.25
C207, 210	24G335	10mF, 16V, Tantalum	.50
C208, 215, 216	24G120	10mF, 15V, Lytic	.25
C209, 213, 217	24G212	.047mF, 250V, Mylar	.50
C211	24G303	.01mF, 100V, Mylar	.25
C212, 219	24G214	1000pF, 500V, Disc	.25
C214	24G331	.01mF, 1000V, Mylar	.50
C218, 222	24G289	.47mF, 100V, Film	.75
C221	24G237	.047mF, 33V, Film	.25
C225	24G207	.01mF, 100V, Disc	.25
C226	24G95	82pF, 100V, Disc	.25
C227	24G230	130pF, 100V, Film	.25
C228	24G309	.22mF, 100V, Mylar	.25
C229	24G77	20pF, 500V, Disc	.25

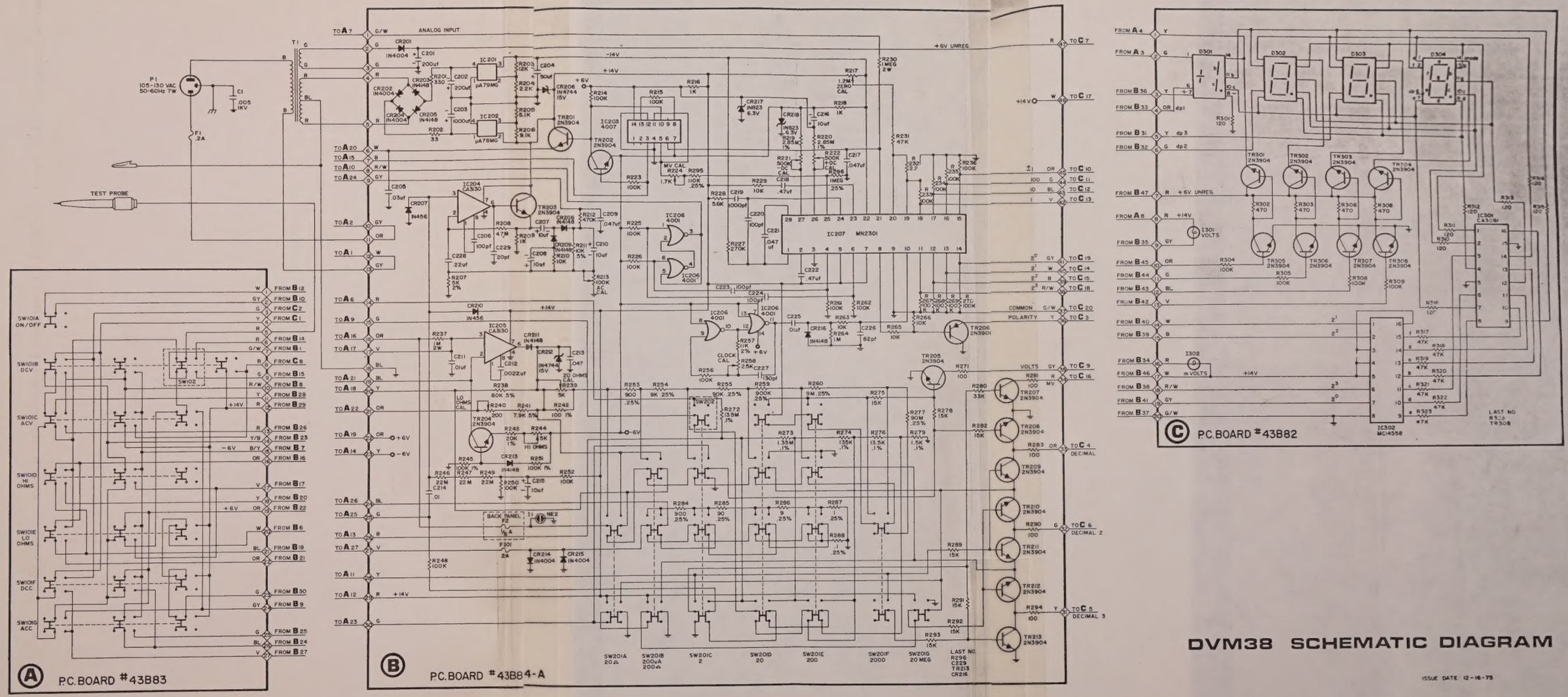
DISPLAY BOARD

IC301	69G19	IC, CA3081	2.75
IC302	69G18	IC, MC14558	3.75
TR301-308	19A33	Transistor, 2N3904	.50
I301, 302	20G15	Lamp, 10ES	1.00
D301	23G58	Display, L.E.D., ± 1	4.50
D302, 303, 304	23G57	Display, L.E.D., 7 segment	4.50

CHASSIS COMPONENTS

A	143B83	Function Board Assembly	32.00
B	143B84	Range Board Assembly	
C	143B82	Display Board Assembly	41.00
C1	24G305	Capacitor, .005uF, 3KV	.25
T1	28B65	Transformer	5.25
F1	44G5	Fuse, .2A, 3AG	.50
F2	44G13	Fuse, 1/16A, 3AG	.11
	64G28	Fuse Holder	1.25
	27G16	Line Cord, SPT-3, 6ft.	1.75
	63K16	Red Filter	1.00
	21A58	Pushbutton	.25
	37G25	Rubber foot	.25
	39G91	Probe and Lead Assembly	8.00
	25A132	Probe Switch	1.25

Components not listed are standard replacement parts and may be purchased locally. When ordering parts, please specify instrument model number, schematic reference, part number, and description. Please include remittance (check or money order) with your order, otherwise invoice will be shipped C.O.D. Minimum billing is $3.00. Prices and specifications in effect at date of printing and are subject to change without notice.



DVM38 SCHEMATIC DIAGRAM

ISSUE DATE: 12-16-75